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(21)Application number : 07-343582 (71)Applicant : MURATA MFG CO LTD

(22)Date of filing : 28.12.1995 (72)Inventor : IKADA KATSUHIRO

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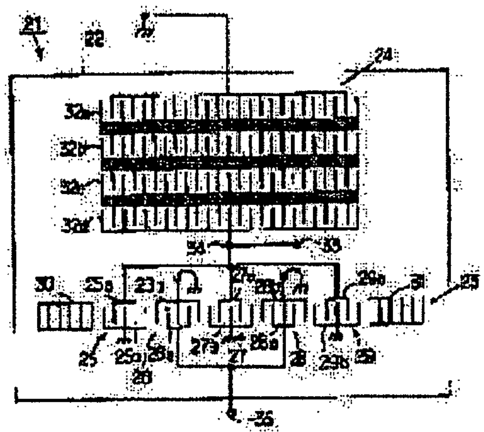
(54) SURFACE ACOUSTIC WAVE DEVICE AND ITS MANUFACTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a surface acoustic wave device in which the loss in a pass band is low with excellent power resistance performance, the reflection coefficient at a block band is high, the attenuation at an attenuation band toward a lower frequency of the pass band is improved more than that at the pass band and the attenuation at an attenuation band toward a higher frequency of the pass band is improved more than that at the pass band.



SOLUTION: A multi-electrode longitudinal coupling dual mode SAW resonator filter 23 having at least 5 interdigital transducers(IDTs) 25-29 is formed on a piezoelectric substrate 22 made of a 36° Y-cut X propagation $LiTaO_3$. The surface acoustic wave device 21 is configured by connecting a parallel arm resonator 24 between a ground potential point and a connection point 34 between an input terminal 33 and the input IDTs 25, 27, 29 so that the resonance frequency is located to a frequency area toward the lower frequency than the frequency of the pass band of a SAW resonator filter 23.

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	9/145		7259－5J		9/145	Z
	9/25		7259－5J		9/25	Z
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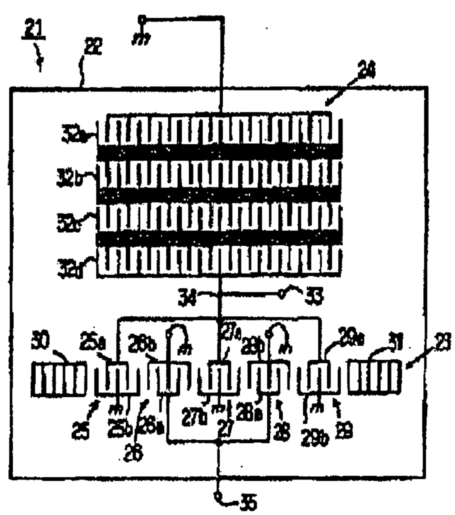
(71)出願人 000006231
株式会社村田製作所
京都府長岡京市天神二丁目26番10号
(72)発明者 [illegible] 克弘
京都府長岡京市天神二丁目26番10号 株式会社村田製作所内
(74)代理人 弁理士 宮▼崎▲ 主税 (外1名)

(54)【発明の名称】 弾性表面波装置及びその製造方法

(57)【要約】
【課題】 通過帯域内において低損失であり、耐電力性に優れ、阻止域における反射係数が大きくされており、さらに通過帯域よりも低周波数側の減衰域における減衰量を拡大し得るだけでなく、通過帯域よりも高周波数側の減衰域における減衰量も拡大し得る弾性表面波装置を提供し得る。
【解決手段】 36°YカットX伝搬LiTaO3よりなる圧電基板22上に、少なくとも5個のIDT25～29を有する多電極型縦結合2重モードSAW共振子フィルタ23を構成し、入力端子33と入力側IDT25，27，29との間の接続点34と、アース電位との間に、共振周波数がSAW共振子フィルタ23の通過帯域よりも低周波数側の周波数領域に位置するように並列腕共振子24を接続してなる弾性表面波装置21。



【特許請求の範囲】

【請求項１】　圧電基板または圧電薄膜を有する表面波基板と、
前記圧電基板上または前記圧電薄膜に接するように形成されている５個以上のインターデジタルトランスデューサ及び前記インターデジタルトランスデューサが設けられている領域の表面波伝搬方向両側に配置された一対の反射器を有する多電極型縦結合２重モードＳＡＷ共振子フィルタと、
反射器を有せず、かつ共振周波数が前記ＳＡＷ共振子フィルタの通過帯域よりも低周波数側に位置するように前記ＳＡＷ共振子フィルタに並列接続された一端子対ＳＡＷ共振子よりなる並列腕共振子とを備え、
入力側端子が、前記ＳＡＷ共振子フィルタと前記並列腕共振子との接続点であることを特徴とする、弾性表面波装置。

【請求項２】　前記多電極型縦結合２重モードＳＡＷ共振子フィルタは、５以上の奇数個のインターデジタルトランスデューサを有し、該奇数個のインターデジタルトランスデューサは表面波伝搬方向に沿って交互に入力側インターデジタルトランスデューサまたは出力側インターデジタルトランスデューサとされており、
前記一対の反射器に最も近い２つのインターデジタルトランスデューサを含む入力側インターデジタルトランスデューサの電極指の数の総和が、出力側インターデジタルトランスデューサの電極指の数の総和よりも多くされており、かつ前記入力側インターデジタルトランスデューサに前記並列腕共振子が接続されている、請求項１に記載の弾性表面波装置。

【請求項３】　前記圧電基板は、３６°ＹカットＸ伝搬ＬｉＴａＯ３基板により構成されており、かつ前記インターデジタルトランスデューサの電極指の幅ｗと表面波の波長λとの比ｗ／λが、ｗ／λ≦０．３２とされている、請求項２に記載の弾性表面波装置。

【請求項４】　前記出力側インターデジタルトランスデューサに接続されており、かつその反共振周波数が前記ＳＡＷ共振子フィルタの通過帯域よりも高周波数側となるように接続された一端子対ＳＡＷ共振子よりなる少なくとも１個の直列腕共振子をさらに備える、請求項２に記載の弾性表面波装置。

【請求項５】　圧電基板または圧電薄膜を有する表面波基板と、
前記圧電基板上または前記圧電薄膜に接するように形成されている５以上の奇数個のインターデジタルトランスデューサ及び該インターデジタルトランスデューサが設けられている領域の表面波伝搬方向両側に配置された反射器とを有する多電極型縦結合２重モードＳＡＷ共振子フィルタと、
反射器を有せず、かつ共振周波数が前記ＳＡＷ共振子フィルタの通過帯域よりも低周波数側の周波数領域に位置するようにＳＡＷ共振子フィルタに並列接続された一端子対ＳＡＷ共振子よりなる第１の並列腕共振子と、前記出力側インターデジタルトランスデューサに接続されており、かつその反共振周波数が前記ＳＡＷ共振子フィルタの通過帯域よりも高周波数側となるように接続された一端子対ＳＡＷ共振子よりなる少なくとも１個の直列腕共振子とを備え、
前記ＳＡＷ共振子フィルタにおいて、一対の反射器に最も近い２つのインターデジタルトランスデューサを含む入力側インターデジタルトランスデューサの電極指の数の総和が、出力側インターデジタルトランスデューサの電極指の数の総和よりも多くされており、かつ前記入力側インターデジタルトランスデューサに前記第１の並列腕共振子が接続されており、かつ前記出力側インターデジタルトランスデューサに、その共振周波数が前記直列腕共振子の反共振周波数よりも高周波数側となるように第２の並列腕共振子が接続されている弾性表面波装置の製造方法において、
前記第２の並列腕共振子を接続した後に、少なくとも１個の前記直列腕共振子を接続することを特徴とする、弾性表面波装置の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、帯域フィルタとして用いられる弾性表面波装置に関し、特に、多電極型縦結合２重モードＳＡＷ共振子フィルタを用いて構成された弾性表面波装置の改良に関する。

【０００２】

【従来の技術】移動体通信機などの各種通信機器において、帯域フィルタとして弾性表面波装置が多用されている。ところで、携帯電話のアンテナトップの受信側において帯域フィルタとして用いられている弾性表面波装置では、低損失であり、かつ通過帯域外の減衰量が大きいことが求められる。

【０００３】そこで、低損失化、通過帯域内におけるＶＳＷＲ（定在波比）の低減並びに阻止域における減衰量の拡大が図られている弾性表面波装置が、特開平６－９７５２５号公報に開示されている。

【０００４】この先行技術に記載の弾性表面波装置の電極構造を図１に示す。この弾性表面波装置では、圧電基板上において、３電極型ＳＡＷ共振子フィルタ１と、直列腕共振子２と、並列腕共振子３とが構成されている。

【０００５】ＳＡＷ共振子フィルタ１は、中央領域に３個のインターデジタルトランスデューサ（以下、ＩＤＴ）４～６を有する。ＩＤＴ４～６は、それぞれ、一対のくし型電極４ａ，４ｂ，５ａ，５ｂ，６ａ，６ｂからなる。ＩＤＴ４～６が設けられている領域の表面波伝搬方向両側には、反射器７，８が配置されている。また、ＩＤＴ４，６の一方のくし型電極４ａ，６ａは、共通接続されて、接続点９に接続されている。この接続点９

と、入力端子１０との間に、直列腕共振子２が接続されている。直列腕共振子２は、ＩＤＴ１１の両側に反射器１２，１３を配置した構造を有する。

【０００６】また、出力側ＩＤＴ５の一方のくし型電極５ａが接続点１４に接続されている。接続点１４は、出力端子１５に接続されている。また、接続点１４とアース電位との間に並列腕共振子３が接続されている。並列腕共振子３は、ＩＤＴ１６と、ＩＤＴ１６の両側に配置された反射器１７，１８とを有する。

【０００７】ＳＡＷ共振子フィルタ１のくし型電極４ｂ，５ｂ，６ｂは、それぞれ、アース電位に接続されている。また、上記直列腕共振子２の共振周波数が、ＳＡＷ共振子フィルタ１の通過帯域内に位置するように該直列腕共振子２が接続されており、かつ並列腕共振子３の反共振周波数がＳＡＷ共振子フィルタ１の通過帯域内に位置するように該並列腕共振子３が並列接続されている。

【０００８】すなわち、上記弾性表面波装置では、３電極型縦結合２重モードＳＡＷ共振子フィルタ１の３個のＩＤＴ４～６のうち、外側のＩＤＴ４，６に直列腕共振子２を、共振周波数がＳＡＷ共振子フィルタ１の通過帯域内に位置するように直列接続することにより、該直列腕共振子のインピーダンス－周波数特性により、ＳＡＷ共振子フィルタ１の外側のＩＤＴ４，６側におけるＶＳＷＲの低減が図られ、かつ通過帯域外の、特に高周波数側の減衰域における減衰量が拡大されている。また、上記ＳＡＷ共振子フィルタの中央のＩＤＴ５に、上記並列腕共振子３を、その反共振周波数がＳＡＷ共振子フィルタ１の通過帯域内に位置するように並列接続することにより、該並列腕共振子３のインピーダンス－周波数特性により、ＳＡＷ共振子フィルタ１の中央のＩＤＴ５側におけるＶＳＷＲの低減並びに通過帯域外、特に低周波数側の減衰域における減衰量の拡大が図られている。

【０００９】

【発明が解決しようとする課題】上述した弾性表面波装置では、３電極型縦結合２重モードＳＡＷ共振子フィルタ１に、直列腕共振子２及び並列腕共振子３を上記のように接続することにより、損失の低減並びに通過帯域外の減衰域における減衰量の拡大が図られている。

【００１０】他方、携帯電話などのアンテナトップでは、その受信側（Ｒｘ側）フィルタの阻止域（送信側の通過帯域）には、送信側からの大きな電力が印加される。このような受信側フィルタとして、上記弾性表面波装置を用いた場合には、送信側からの大電力に耐え得ないことがあり、例えば２Ｗの電力が印加された場合には、瞬時に破壊してしまうという問題があった。

【００１１】また、上記弾性表面波装置を携帯電話用のアンテナトップの受信側フィルタとして用いる場合には、ストリップラインなどを用いて阻止域のインピーダンスが開放となるように設定して、例えば誘電体共振器を用いたフィルタやＳＡＷフィルタからなる送信側フィルタに接続している。しかしながら、この場合、送信側の損失を抑制するには、送信側の通過帯域における受信側フィルタの反射係数が大きいことが望まれるが、上記弾性表面波装置では、送信側の通過帯域における反射係数を十分に高め得なかった。

【００１２】加えて、ＳＡＷ共振子フィルタの一般的な特徴として、通過帯域よりも高周波数側の減衰域における減衰量が十分でなく、従って、高周波数側の減衰域における減衰量の拡大が強く求められている。

【００１３】本発明は、上述した従来の弾性表面波装置の欠点を解消し、低損失であり、かつ通過帯域よりも低周波数側の減衰域における減衰量を拡大し得るだけでなく、耐電力性に優れ、さらに通過帯域よりも高周波数側における減衰域の減衰量が拡大されている弾性表面波装置を提供することを目的とする。

【００１４】

【課題を解決するための手段及び発明の効果】本発明は、上記課題を達成するために成されたものであり、本発明の広い局面によれば、圧電基板または圧電薄膜を有する表面波基板と、前記圧電基板上または前記圧電薄膜に接するように形成されている５個以上のＩＤＴ及び前記ＩＤＴが設けられている領域の表面波伝搬方向両側に配置された一対の反射器を有する多電極型縦結合２重モードＳＡＷ共振子フィルタと、反射器を有せず、かつ共振周波数が前記ＳＡＷ共振子フィルタの通過帯域よりも低周波数側に位置するように前記ＳＡＷ共振子フィルタに並列接続された一端子対ＳＡＷ共振子よりなる並列腕共振子とを備え、入力側端子が、前記ＳＡＷ共振子フィルタと前記並列腕共振子との接続点であることを特徴とする、弾性表面波装置が提供される。

【００１５】本発明によれば、多電極型縦結合２重モードＳＡＷ共振子フィルタに上記並列腕共振子が上記の関係で並列接続されているため、入力端子から印加される電力は、ＳＡＷ共振子フィルタと並列腕共振子とに分散されることになり、それによって耐電力性が効果的に高められる。

【００１６】また、上記並列腕共振子は、その共振周波数がＳＡＷ共振子フィルタの通過帯域よりも低周波数側の領域に位置するように設けられているため、通過帯域の低周波数側の減衰域における減衰量が高められる。加えて、後述の実施形態の説明から明らかなように、阻止域における反射係数も高められる。

【００１７】また、本発明の特定的な局面では、上記多電極型縦結合２重モードＳＡＷ共振子フィルタは、５以上の奇数個のＩＤＴを有し、該奇数個のＩＤＴは、表面波伝搬方向に沿って交互に入力側ＩＤＴまたは出力側ＩＤＴとされている。この場合、上記一対の反射器に最も近い２個のＩＤＴは入力側ＩＤＴとされる。また、該一対の反射器に最も近い２個のＩＤＴを含む入力側ＩＤＴ

の電極指の数の総和が、出力側ＩＤＴの電極指の数の総和よりも多くされ、上記並列腕共振子は、入力側ＩＤＴに接続されている。

【００１８】この特定的な局面により提供される弾性表面波装置では、上記本発明の広い局面により提供される弾性表面波装置の作用効果に加えて、入力側ＩＤＴの数が出力側ＩＤＴの数よりも多くなるため、すなわち一対の反射器に最も近い２個のＩＤＴが入力側ＩＤＴとなるように入力側ＩＤＴ及び出力側ＩＤＴが表面波伝搬方向に沿って交互に配置されているため、電力が印加される側のＩＤＴの電極指総面積が大きくなり、従って、入力側端子の阻止域における耐電力性をより一層高めることができる。

【００１９】また、本発明のさらに特定的な局面では、圧電基板として、３６°Ｙカット×伝搬ＬｉＴａＯ３基板が用いられ、ＩＤＴの電極指の幅ｗと表面波の波長λとの比ｗ／λが、ｗ／λ≦０．３２とされる。この場合、圧電基板として、電気機械結合係数が大きくかつ温度特性が良好な３６°Ｙカット×伝搬ＬｉＴａＯ３基板が用いられているため、温度特性が良好であり、かつ十分な帯域幅を有する弾性表面波装置を容易に提供し得る。加えて、ＩＤＴの電極指の幅ｗと表面波の波長λとの比が上記のように０．３２以下とされているため、後述の実施形態の説明から明らかなように、５個以上の奇数個のＩＤＴを構成した構成において、相対的に多数である入力側ＩＤＴの電極指総面積を相対的に出力側ＩＤＴの電極指総面積に比べてより一層大きくすることができ、それによって耐電力性をさらに高め得る。

【００２０】本発明においては、好ましくは、上記本発明の特定の局面により提供される５個以上の奇数個のＩＤＴを有する構成において、出力側ＩＤＴには、反共振周波数がＳＡＷ共振子フィルタの通過帯域よりも高周波数側となるように一端子対ＳＡＷ共振子よりなる少なくとも１個の直列腕共振子が接続される。少なくとも１個の直列腕共振子をさらに接続した構成では、耐電力性、阻止域における反射係数だけでなく、位相を損なうことなく通過帯域よりも高周波数側の減衰域における減衰量を効果的に増大し得る。

【００２１】また、本発明の別の局面では、圧電基板または圧電薄膜を有する表面波基板と、前記圧電基板上または前記圧電薄膜に接するように形成されている５以上の奇数個のインターデジタルトランスデューサ及び該インターデジタルトランスデューサが設けられている領域の表面波伝搬方向両側に配置された反射器とを有する多電極型縦結合２重モードＳＡＷ共振子フィルタと、反射器を有せず、かつ共振周波数が前記ＳＡＷ共振子フィルタの通過帯域よりも低周波数側の周波数領域に位置するようにＳＡＷ共振子フィルタに並列接続された一端子対ＳＡＷ共振子よりなる第１の並列腕共振子と、前記出力側インターデジタルトランスデューサに接続されており、かつその反共振周波数が前記ＳＡＷ共振子フィルタの通過帯域よりも高周波数側となるように接続された一端子対ＳＡＷ共振子よりなる少なくとも１個の直列腕共振子とを備え、前記ＳＡＷ共振子フィルタにおいて、一対の反射器に最も近い２つのインターデジタルトランスデューサを含む入力側インターデジタルトランスデューサの電極指の数の総和が、出力側インターデジタルトランスデューサの電極指の数の総和よりも多くされており、かつ前記入力側インターデジタルトランスデューサに前記第１の並列腕共振子が接続されており、かつ前記出力側インターデジタルトランスデューサに、その共振周波数が前記直列腕共振子の反共振周波数よりも高周波数側となるように第２の並列腕共振子が接続されている弾性表面波装置の製造方法において、前記第２の並列腕共振子を接続した後に、少なくとも１個の前記直列腕共振子を接続することを特徴とする、弾性表面波装置の製造方法が提供される。この製造方法によれば、上述した本発明の弾性表面波装置の作用効果に加えて、さらに通過帯域よりも高周波数側において、より広い周波数範囲にわたり減衰量を拡大することができる。

【００２２】

【発明の実施の形態】以下、本発明の非限定的な実施形態を説明することにより、本発明を明らかにする。

【００２３】第１の実施形態

図２は、本発明の第１の実施形態に係る弾性表面波装置の略図的平面図である。

【００２４】弾性表面波装置２１は、圧電基板２２を用いて構成されている。圧電基板２２は、３６°Ｙカット×伝搬ＬｉＴａＯ３基板よりなる。圧電基板２２上に後述の種々の電極を形成することにより多電極型縦結合２重モードＳＡＷ共振子フィルタ２３と並列腕共振子２４とが構成されている。

【００２５】すなわち、圧電基板２２上に、５個のＩＤＴ２５～２９がＳＡＷ共振子フィルタ２３における表面波伝搬方向に沿って配置されている。ＩＤＴ２５～２９のうち、ＩＤＴ２５，２７，２９が入力側ＩＤＴであり、ＩＤＴ２６，２８が出力側ＩＤＴである。各ＩＤＴ２５～２９は、それぞれ、一対のくし型電極２５ａ，２５ｂ～２９ａ，２９ｂを有する。ＩＤＴ２５～２９が設けられている領域の表面波伝搬方向外側には、反射器３０，３１が形成されている。反射器３０，３１は、複数本の電極指を有するグレーティング反射器により構成されている。

【００２６】また、並列腕共振子２４は、一端子対ＳＡＷ共振子により構成されており、５個のＩＤＴ３２ａ～３２ｄを直列に接続してなる構成を有する。各ＩＤＴ３２ａ～３２ｄは、それぞれ、互いに間挿し合う複数本の電極指を有する一対のくし型電極により構成されている。また、ＩＤＴ３２ａ～３２ｄの開口長及び電極指の対数は全て同一とされている。

【００２７】並列腕共振子２４は、その共振周波数が、ＳＡＷ共振子フィルタ２３の通過帯域よりも低周波数側であって、特に、阻止域よりも高周波数側となるように、入力側ＩＤＴ２５，２９のくし型電極２５ａ，２９ａに電気的に接続されている。すなわち、入力端子３３に接続されている接続点３４に、ＳＡＷ共振子フィルタ２３の入力側ＩＤＴ２５，２７，２９の第１のくし型電極２５ａ，２７ａ，２９ａが接続されていると共に、該接続点３４に並列腕共振子２４が接続されている。並列腕共振子２４の反対側の端子は、アース電位に接続されている。また、ＳＡＷ共振子フィルタ２３の入力側ＩＤＴ２５，２７，２９の第２のくし型電極２５ｂ，２７ｂ，２９ｂもアース電位に接続されている。

【００２８】また、出力側ＩＤＴ２６，２８の第１のくし型電極２６ａ，２８ａは共通接続されて、出力端子３５に接続されている。ＩＤＴ２６，２８の第２のくし型電極２６ｂ，２８ｂは、それぞれ、アース電位に接続されている。

【００２９】上記ＳＡＷ共振子フィルタ２３の減衰量周波数特性を、図４に示す。なお、図４において、実線Ｂで示す特性は、実線Ａで示す特性の要部を、縦軸の挿入損失を縦軸の右側のスケールに拡大して示した特性である。

【００３０】また、上記ＳＡＷ共振子フィルタ２３のインピーダンススミスチャートを図５（ａ）及び（ｂ）に示す。なお、図５（ａ）は、ＩＤＴ２５，２７，２９側の端子から見た特性を、図５（ｂ）はＩＤＴ２６，２８側の端子から見た特性である。なお、上記ＳＡＷ共振子フィルタ２３の通過帯域は、９３５～９６０ＭＨｚであり、低周波数側の阻止域は８９０～９１５ＭＨｚである。

【００３１】前述したように、本実施形態の弾性表面波装置２１では、上記ＳＡＷ共振子フィルタ２３に並列腕共振子２４が上記のように接続されているが、その全体としての通過帯域内外の減衰量周波数特性を図６に示す。なお、図６において、実線Ｄは、実線Ｃで示した特性の要部を縦軸の挿入損失を縦軸の右側のスケールで拡大して示した特性である。

【００３２】図４と図６とを比較すれば明らかなように、図６に示した特性では、通過帯域よりも低周波数側の領域において、通過帯域近傍で減衰量が大きくなっていることがわかる。すなわち、本実施形態によれば、ＳＡＷ共振子フィルタ２３に上記並列腕共振子２４を上記のように接続することにより、通過帯域外の低周波数側領域における減衰量が、特に、上記阻止域の中の高周波数側領域において減衰量が効果的に高められることがわかる。

【００３３】また、図７（ａ）及び（ｂ）は、本実施形態の弾性表面波装置２１のインピーダンススミスチャートを示し、（ａ）は入力端子から見た特性を、（ｂ）は出力端子から見た特性を示す。図５（ａ）に示した特性と、図７（ａ）に示した特性とを比較すれば、図７（ａ）に示されている特性の方が、阻止域すなわち相手側の通過帯域における反射係数が大きくなっていることがわかる。

【００３４】加えて、本実施形態の弾性表面波装置２１では、入力端子３３には、ＩＤＴ２５，２７，２９だけでなく、並列腕共振子２４を構成しているＩＤＴ３２ａ～３２ｄが接続されている。従って、入力側端子に接続されたＩＤＴの電極指総面積は、図１に示した従来の弾性表面波装置におけるＩＤＴ５，１６の電極指総面積に対して大きくなることがわかる。

【００３５】すなわち、本実施形態では、上記並列腕共振子２４がＳＡＷ共振子フィルタ２３に上記の関係で接続されているため、通過帯域外の減衰域、特に低周波数側の減衰域において減衰量を拡大することができる。加えて、例えば携帯電話のアンテナトップにおいて受信側フィルタとして用いた場合には、阻止域における反射係数が高くされ得るため、送信側の通過帯域における損失を効果的に抑制することができる。

【００３６】また、上記並列腕共振子２４が接続されているため、上述したように、入力端子から印加された電力は、ＳＡＷ共振子フィルタ２３と並列腕共振子２４とに分散されるため、耐電力性が高められる。

【００３７】ところで、弾性表面波装置に大電力を投入した場合の破壊は、表面波を励振させたときに機械的ストレスがＩＤＴの電極に発生し、ＩＤＴを構成している電極中の原子がマイグレーションが起こすことによると考えられている。

【００３８】図３は、ＩＤＴにおける上記電極指の幅ｗ、表面波の波長λ及び交叉幅ｔとの関係を示す図である。図３を参照して、耐電力性を高め得るさらなる条件を説明する。

【００３９】例えば図１に示した従来の３電極型縦結合２重モードＳＡＷ共振子フィルタでは、広帯域化を図るためにＩＤＴの電極指の本数を減らした場合、入出力のインピーダンスを５０Ωとするために、ＩＤＴの交叉幅ｔを大きくするか、ＩＤＴの電極指の幅ｗを大きくする必要があった。従って、従来、ＩＤＴにおける抵抗損失を低減するために、上記交叉幅ｔを小さくし、電極指の幅ｗを波長λの０．３５倍以上まで太くしていた。

【００４０】これに対して、本実施形態の弾性表面波装置２１では、ＩＤＴ２５～２９の５個のＩＤＴが設けられているため、３電極型ＳＡＷ共振子フィルタの場合と同じ交叉幅とした場合であっても、各ＩＤＴ２５～２９における電極指の幅を３電極型ＳＡＷ共振子フィルタのＩＤＴの場合の電極指の幅よりも細くして入出力インピーダンスを５０Ω純抵抗とすることができる。

【００４１】本願発明者は、ＩＤＴの数を変化させて、入出力インピーダンスが５０Ω純抵抗となる電極指の幅

ｗと交叉幅ｔとの関係を調べた。その結果、図８に示す結果が得られた。なお、図８に示す関係においては、ｔ／λ＝０．２５における比帯域幅が４％と一定である場合を基準に、比帯域幅を一定として上記関係を求めたものである。

【００４２】なお、図８の実線Ｅ～Ｈは、それぞれ、実線Ｅ…３電極型、実線Ｆ…５電極型、実線Ｇ…７電極型、実線Ｈ…９電極型の場合の関係を示す。図８から明らかなように、交叉幅ｔが同じ場合、すなわち比ｔ／λが等しい場合、３電極型において比ｗ／λ＝０．３５以上に相当の構成を、５電極型では、比ｗ／λ＝０．１５以下で実現し得ることがわかる。すなわち、広帯域化を図るために、ＩＤＴにおける電極指の本数を減らした場合に、入出力間のインピーダンスを所定の値とするために、本実施形態では、電極指の幅を太くする必要のないことがわかる。

【００４３】他方、電極間マイグレーションにより短絡に至る寿命時間は、ＩＤＴにおける信号線とアース線との間隔が広いほど長くなることがわかっている。従って、高周波化によってＩＤＴの波長λが短くなった場合、本実施形態では、電極指の幅ｗを上記のように狭くし得るため、耐電力性を効果的に高め得ることがわかる。

【００４４】本実施形態では、上記のように、電極指の幅ｗを細くし得ることにより耐電力性を高め得るだけでなく、前述したように、入力側ＩＤＴが３個のＩＤＴ２５，２７，２９と、出力側のＩＤＴ２６，２８に比べて多くされており、さらに上記並列腕共振子２４のＩＤＴ３２ａ～３２ｄが設けられているため、電力が印加される側のＩＤＴの電極の総面積を出力側ＩＤＴの電極の総面積よりも大きくすることができるため、それによっても入力側端子の阻止域における耐電力性を効果的に高め得る。

【００４５】第１の実施形態の変形例

第１の実施形態の弾性表面波装置２１は上述のように構成されていたが、好ましくは、上記弾性表面波装置のＳＡＷ共振子フィルタ２３のＩＤＴ２５～２９における電極指の幅ｗと、表面波の波長λとの比は、ｗ／λ≦０．３２とされ、それによって耐電力性がより一層高められる。すなわち、ＳＡＷ共振子フィルタにおけるＩＤＴの電極指交叉幅を小さくすると、電極面積が小さくなるため耐電力性が劣化することになる。そこで、種々の数のＩＤＴを有する電極構成における電極指の幅ｗとＩＤＴの数によって、耐電力性に影響するＩＤＴの電極指面積の総和がどのように変化するかを調べた。図９～図１１は、それぞれ、ＩＤＴが５個、７個及び９個の場合に、電極指の交叉幅ｔと波長λとの比ｔ／λに入力側ＩＤＴ２５，２７，２９の電極指の本数ｎを掛けた値と、比ｗ／λとの関係を示す図である。ここで、交叉幅ｔと、電極指の本数ｎの積は、ＩＤＴの電極面積に相当する量を示し、それぞれ、ＩＤＴが５個、７個及び９個の場合の入力側ＩＤＴの電極指の総本数は、ｎ５＝９１、ｎ７＝１３６及びｎ９＝１９５である。

【００４６】また、従来の３個のＩＤＴを用いた弾性表面波装置では、前述したように電極指の幅ｗが波長λの０．３５倍以上とされていた。そこで、図９～図１１においては比較のために、●印を付して、ｗ／λ＝０．３５の場合の従来の３電極型弾性表面波装置におけるｔ×ｎ／λの値を併せて示した。

【００４７】図９～図１１から明らかなように、５個以上のＩＤＴを用いた構成では、電極の幅ｗが一定の場合、ＩＤＴの数が増加するにつれて、面積に相当する量であるｔ×ｎ／λが大きくなっており、その量が最も小さいのはＩＤＴを５個用いた場合である。

【００４８】従って、図９～図１１に示されているように、５個以上のＩＤＴを用いる場合、比ｗ／λを０．３２以下とすれば、入力側ＩＤＴの電極総面積を大きくすることができ、より一層耐電力性を高め得ることがわかる。

【００４９】第２の実施形態

図１２は、本発明の第２の実施形態に係る弾性表面波装置を説明するための略図的平面図である。弾性表面波装置４１は、圧電基板４２を用いて構成されており、圧電基板４２は、３６°ＹカットＸ伝搬ＬｉＴａＯ$_3$基板からなる。圧電基板４２上に、後述の種々の電極を形成することにより、多電極型縦結合ＳＡＷ共振子フィルタ４３と、並列腕共振子４４と、直列腕共振子６０とが構成されている。

【００５０】ＳＡＷ共振子フィルタ４３及び並列腕共振子４４は、第１の実施形態に係るＳＡＷ共振子フィルタ２３及び並列腕共振子２４と同様に構成されている。従って、同一部分については、同一の参照番号を付することにより、その詳細な説明は省略する。

【００５１】本実施形態が、第１の実施形態と異なるところは、ＳＡＷ共振子フィルタ４３の出力側に、直列腕共振子６０が接続されていることにある。すなわち、直列腕共振子６０は、中央に配置されたＩＤＴ６１と、ＩＤＴ６１の表面波伝搬方向外側に配置されたグレーティング反射器よりなる反射器６２，６３とを有する。ＩＤＴ６１は、互いに間挿し合う複数本の電極指を有する一対のくし型電極６１ａ，６１ｂを有する。ＳＡＷ共振子フィルタ４３の出力側ＩＤＴ２６，２８の一方のくし型電極２６ａ，２８ａが共通接続されて、直列腕共振子６０のくし型電極６１ａに接続されている。

【００５２】従って、第２の実施形態に係る弾性表面波装置４１では、入力端子３３に接続されている接続点３４に、並列腕共振子４４とＳＡＷ共振子フィルタ４３の入力側ＩＤＴ２５，２７，２９が接続されている。他方、出力側ＩＤＴ２６，２８が、直列腕共振子６０を介して出力端子３５に接続されている。なお、ＳＡＷ共振

子フィルタ４３の通過帯域は、第１の実施形態の場合と同様に、９３５～９６０ＭＨｚであり、阻止域は８９０～９１５ＭＨｚである。

【００５３】並列腕共振子４４は、その共振周波数が上記阻止域よりも高周波数側の領域かつ通過帯域よりも低周波数側の領域となるように、ＩＤＴ２５，２７，２９に接続されている。また、直列腕共振子６０は、その反共振周波数が、ＳＡＷ共振子フィルタ４３の通過帯域よりも高周波数側の減衰域に位置するようにＩＤＴ２６，２８に接続されている。

【００５４】本実施形態の弾性表面波装置４１の全体としての通過帯域内外の減衰量周波数特性を図１３に示す。なお、図１３の実線Ｊは、実線Ｉで示した特性の要部を縦軸の挿入損失を縦軸の右側のスケールで拡大して示す特性である。

【００５５】図１３に示す減衰量周波数特性を、第１の実施形態の弾性表面波装置の減衰量周波数特性である図６と比較すれば明らかなように、本実施形態の弾性表面波装置４１では、通過帯域よりも高周波数側の減衰域においても減衰量が大きくなっていることがわかる。すなわち、上記阻止域内の高周波数側の周波数領域における減衰量が拡大されるだけでなく、通過帯域よりも高周波数側の減衰域においても減衰量が大きくなることがわかる。

【００５６】すなわち、弾性表面波装置４１では、先ず、ＳＡＷ共振子フィルタ４３に、並列腕共振子４４が、その共振周波数が阻止域の高周波数側の周波数領域となるように、入力側ＩＤＴ２５，２７，２９に接続されているため、通過帯域外の低周波数側の周波数領域、特に阻止域内の高周波数側の周波数領域における減衰量が拡大されている。

【００５７】また、上記並列腕共振子４４の接続により、入力端子１６に印加される電力は、ＳＡＷ共振子フィルタ４３の入力側ＩＤＴ２５，２７，２９と並列腕共振子４４とに分散されることになり、耐電力性が高められる。加えて、ＳＡＷ共振子フィルタ４３では、５個のＩＤＴ２５～２９が設けられており、入力側ＩＤＴが３個のＩＤＴ２５，２７，２９で構成されているため、電極指の本数の多い入力側ＩＤＴに電力が印加されるため、並びに多対であり、かつ複数段のＩＤＴを直列接続してなる並列腕共振子４４が接続されていることにより、電力が印加されるＩＤＴの電極の総面積が拡大されており、それによって入力側端子の阻止域における耐電力性が高められている。

【００５８】加えて、上記直列腕共振子が、その反共振周波数がＳＡＷ共振子フィルタ４３の通過帯域よりも高周波数側の減衰域に位置するように接続されているので、入力側端子の阻止域における上述した耐電力性及び反射係数を損なうことなく、通過帯域よりも高周波数側の減衰域における減衰量の拡大も図られる。

【００５９】なお、本実施形態では、１個の直列腕共振子６０が用いられていたが、２個以上の直列腕共振子が出力端子３５とＳＡＷ共振子フィルタ４３との間に接続されていてもよく、より多くの直列腕共振子を接続することにより、通過帯域よりも高周波数側の周波数領域における減衰量をより一層拡大し得る。

【００６０】また、弾性表面波装置４１を、通過帯域よりも低周波数側の減衰域の一部が阻止域（すなわち相手側の通過帯域）となるような携帯電話のアンテナ共用器として用いる場合には、阻止域のインピーダンスを高めるために、入力端子におけるインピーダンスの位相を回転させる必要がある。入力端子に、直列腕共振子を接続すると、位相の回転方向に対して逆に位相がまわることになるため、線路長の長い位相器が必要となる。ところが、位相器の線路長を長くすると、位相器における損失が大きくなり、かつ位相器のサイズも大きくなる。これに対して、本実施形態では、出力側に直列腕共振子６０が接続されているため、入力端子３３におけるインピーダンスの位相への影響を与えることなく、上記のように、通過帯域よりも高周波数側の減衰域における減衰量の拡大を図り得る。

【００６１】第３の実施形態

図１５は、本発明の第３の実施形態に係る弾性表面波装置を説明するための略図的平面図である。弾性表面波装置８１は、圧電基板８２を用いて構成されており、圧電基板８２は、３６°ＹカットＸ伝搬ＬｉＴａＯ３基板からなる。

【００６２】圧電基板８２上には、種々の後述の電極を形成することにより、５電極型縦結合２重モードＳＡＷ共振子フィルタ８３と、並列腕共振子８４と、直列腕共振子８５と、第２の並列腕共振子８６とが構成されている。もっとも、ＳＡＷ共振子フィルタ８３及び並列腕共振子８４は、第１の実施形態の弾性表面波装置２１のＳＡＷ共振子フィルタ２３及び並列腕共振子２４と同様に構成されている。また、直列腕共振子８５は、第２の実施形態の弾性表面波装置で用いられた直列腕共振子６０と同様に構成されている。従って、同一部分については、同一の参照番号を付することにより、詳細な説明は省略する。

【００６３】本実施形態の弾性表面波装置８１が、第２の実施形態に係る弾性表面波装置４２と異なる点は、さらに、第２の並列腕共振子８６が、接続点８７に接続されていることにある。すなわち、ＳＡＷ共振子８３の出力側ＩＤＴ２６，２８は共通接続されて、接続点８８に接続されており、該接続点８８と直列腕共振子８５との間の接続点８７とアース電位との間に第２の並列腕共振子８６が接続されている。

【００６４】第２の並列腕共振子８６は、一対のくし型電極８９ａ，８９ｂからなるＩＤＴ８９と、ＩＤＴ８９の表面波伝搬方向両側に形成された反射器９０，９１と

を有する。

【００６５】従って、弾性表面波装置８１では、入力端子３３に接続される接続点３４とアース電位との間に並列腕共振子８４が接続されており、かつ接続点３４と出力端子３５との間にＳＡＷ共振子フィルタ８３及び直列腕共振子８５が接続されており、さらに接続点８７すなわちＳＡＷ共振子フィルタ８３の出力側と、アース電位との間に第２の並列腕共振子８６が接続された構成を有する。

【００６６】上記構成において、並列腕共振子８４の共振周波数は、第１の実施形態の場合と同様に、ＳＡＷ共振子フィルタ８３の通過帯域よりも低周波数側に位置するように、特に、低周波数側の減衰域の中でも阻止域の高周波数側に共振周波数が位置するようにＳＡＷ共振子フィルタ８３に並列接続されている。

【００６７】また、直列腕共振子８５は、第２の実施形態の弾性表面波装置４１の場合と同様に、その反共振周波数がＳＡＷ共振子フィルタ８３の通過帯域よりも高周波数側の減衰域に位置するように接続されている。

【００６８】他方、第２の並列腕共振子８６は、その共振周波数が直列腕共振子８５の反共振周波数よりも高周波数側となるように構成されており、かつ第２の並列腕共振子８６を接続した後に、直列腕共振子８５が接続される。

【００６９】なお、上記ＳＡＷ共振子フィルタ８３は、第1，第2の実施形態で用いたＳＡＷ共振子フィルタ２３，４３と同様に、通過帯域は９３５～９６０ＭＨｚであり、阻止域は８９０～９１５ＭＨｚである。

【００７０】第３の実施形態に係る弾性表面波装置８１の減衰量周波数特性を図１６に示す。図１６における実線Ｌは実線Ｋで示した特性の要部を、縦軸の挿入損失を縦軸の右側のスケールで拡大して示す特性である。また、図１７（ａ），（ｂ）は、それぞれ、２個の外側のＩＤＴ２５，２９を含む側の端子及びその反対側の端子のインピーダンススミスチャートをそれぞれ示す。

【００７１】図１６を、第２の実施形態の減衰量周波数特性である図１３と比較すれば明らかなように、本実施形態の弾性表面波装置８１では、通過帯域よりも高周波数側の周波数領域における減衰特性がより一層改善される。すなわち、通過帯域よりも高周波数側の周波数領域において、より広い周波数範囲にわたり大きな減衰量が確保されていることがわかる。これを、図１８～図２１を参照して詳細に説明する。

【００７２】図１８は、図１５に示した弾性表面波装置８１を構成するにあたり、先ず直列腕共振子８５を接続し、しかる後第２の並列腕共振子８６を接続した場合の周波数特性を示し、図１９（ａ）及び（ｂ）はその場合のインピーダンススミスチャートを示す。なお、図１８において、実線Ｎは実線Ｍで示した特性の要部を、縦軸の挿入損失を縦軸の右側のスケールで拡大して示す特性である。また、図１９（ａ）及び（ｂ）は、それぞれ、２個の外側のＩＤＴ２５，２９を含む側の端子及びその反対側の端子のインピーダンススミスチャートをそれぞれ示す。図１８を、図１６と比較すれば明らかなように、通過帯域よりも高周波数側の減衰域における減衰量が小さくなっていることがわかる。

【００７３】また、図２０は、図１５に示した直列腕共振子８５と第２の並列腕共振子８６との総合特性としての減衰量周波数特性を示す。図２０において、実線Ｐは、実線Ｏで示した特性を縦軸の挿入損失について縦軸の右側に示したスケールで拡大して示した特性を示す。また、図２１（ａ）及び（ｂ）は、それぞれ、直列腕共振子側のインピーダンススミスチャート及び並列腕共振子側のインピーダンススミスチャートを示す。図７（ｂ）の通過帯域よりも高周波数側、例えば９８０ＭＨｚ付近におけるインピーダンスに対する図２１（ａ）及び（ｂ）のインピーダンスマッチングにより、９８０ＭＨｚ付近において、減衰量が異なることがわかる。

【００７４】また、図７（ｂ）の通過帯域よりも高周波数側の周波数領域におけるインピーダンスに対し、図２１（ｂ）のインピーダンスの方が５０Ω系で、よりミスマッチングとなるため減衰量が大きくなることがわかる。

【００７５】従って、上記直列腕共振子８５と第２の並列腕共振子８６とをＳＡＷ共振子フィルタ８３に接続する場合には、第２の並列腕共振子８６及び直列腕共振子８５の順に接続することにより、通過帯域よりも高周波数側の周波数領域において、より広い周波数範囲にわたって減衰量を効果的に拡大し得ることがわかる。

【００７６】なお、第３の実施形態の弾性表面波装置８１では、上記第２の並列腕共振子８６を接続したこと、並びに第２の並列腕共振子８６を直列腕共振子８５の前に接続すること以外については、第２の実施形態の弾性表面波装置と同様であるため、第２の実施形態の弾性表面波装置４１における作用効果も同じく得ることもできる。

【００７７】すなわち、第２の実施形態の弾性表面波装置の場合と同様に、通過帯域よりも低周波数側の周波数領域、特に阻止域の高周波数側の周波数領域における減衰量が十分な大きさに確保され、十分な耐電力性を有し、かつ入力側端子の阻止域における耐電力性、反射係数及びインピーダンスの位相を損なうこともない。

【００７８】その他

上述した第１～第３の実施形態では、圧電基板として、上記３６°ＹカットＸ伝搬ＬｉＴａＯ3 基板を用いたが、他の圧電基板、例えばＬｉＮｂＯ3 や水晶などからなる圧電基板を用いてもよく、あるいはチタン酸ジルコン酸鉛系セラミックスのような圧電セラミックスよりなる基板を用いてもよい。さらに、絶縁基板や圧電基板上に圧電薄膜を形成してなる表面波基板を用いてもよい。

上記圧電薄膜としては、ZnO、Ta_2O_5などからなるものを挙げることができる。

【0079】また、IDTや反射器は、適宜の導電性材料により形成し得るが、表面波装置において慣用されているAlやAl合金を用いて形成すればよい。

【図面の簡単な説明】

【図1】従来の弾性表面波装置の一例の電極構造を説明するための平面図。

【図2】本発明の第1の実施形態に係る弾性表面波装置の略図的平面図。

【図3】電極指交叉幅t、電極指の幅w及び表面波の波長λを説明するためのIDTの拡大平面図。

【図4】第1の実施形態で用いられたSAW共振子フィルタのみの減衰量周波数特性を示す図。

【図5】(a)及び(b)は、それぞれ、2個の外側の入力側IDTを含む側の端子のインピーダンススミスチャート及び上記端子とは反対側の端子のインピーダンススミスチャートを示す図。

【図6】第1の実施形態に係る弾性表面波装置の総合特性としての減衰量周波数特性を示す図。

【図7】(a)及び(b)は、第1の実施形態の弾性表面波装置の総合特性として、それぞれ、2個の外側の入力側IDTを含む側の端子のインピーダンススミスチャート及び上記端子とは反対側の端子のインピーダンススミスチャートを示す図。

【図8】図2に示した弾性表面波装置の入出力インピーダンスが50Ω純抵抗となる場合の比t/λと比w/λとの関係を示す図。

【図9】第1の実施形態の弾性表面波装置の入出力インピーダンスが50Ω純抵抗となる場合の比w/λと、比t/λにIDTの電極指の本数nを乗じた値との関係を示す図。

【図10】第1の実施形態の弾性表面波装置の入出力インピーダンスが50Ω純抵抗となる場合の比w/λと、比t/λにIDTの電極指の本数nを乗じた値との関係を示す図。

【図11】第1の実施形態の弾性表面波装置の入出力インピーダンスが50Ω純抵抗となる場合の比w/λと、比t/λにIDTの電極指の本数nを乗じた値との関係を示す図。

【図12】本発明の第2の実施形態に係る弾性表面波装置の略図的平面図。

【図13】第2の実施形態の弾性表面波装置の減衰量周波数特性を示す図。

【図14】(a)及び(b)は、それぞれ、第2の実施形態の弾性表面波装置の2個の外側のIDTを含む入力側端子のインピーダンススミスチャート及び反対側の端子のインピーダンススミスチャートを示す図。

【図15】本発明の第3の実施形態に係る弾性表面波装置の略図的平面図。

【図16】第3の実施形態に係る弾性表面波装置の減衰量周波数特性を示す図。

【図17】(a)及び(b)は、第3の実施形態の弾性表面波共振子におけるインピーダンススミスチャートを示し、(a)は、2個の外側のIDTを含む入力側の端子のインピーダンススミスチャートを、(b)は、上記端子とは反対側の端子のインピーダンススミスチャートを示す図。

【図18】第3の実施形態の弾性表面波装置において、直列腕共振子を接続した後に並列腕共振子を接続した場合の総合特性としての減衰量周波数特性を示す図。

【図19】(a)及び(b)は、それぞれ、第3の実施形態の弾性表面波装置において、並列腕共振子を接続した後に直列腕共振子を接続した場合の総合特性としてのインピーダンススミスチャートを示し、(a)は2個の外側のIDTを含む側の端子のインピーダンススミスチャートを、(b)は上記端子とは反対側の端子のインピーダンススミスチャートを示す図。

【図20】第3の実施形態で用いられている並列腕共振子と直列腕共振子の総合特性としての減衰量周波数特性を示す図。

【図21】(a)及び(b)は、それぞれ、第3の実施形態で用いられている第2の並列腕共振子及び直列腕共振子の総合特性でのインピーダンススミスチャートを示し、(a)は、直列腕共振子側端子から見たインピーダンススミスチャートを、(b)は、並列腕共振子側端子から見たインピーダンススミスチャートを示す図。

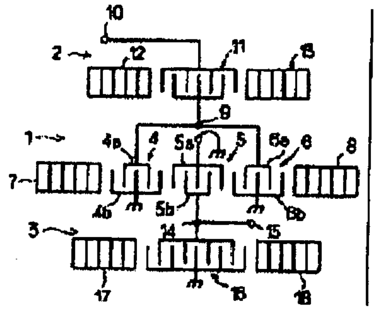
【符号の説明】

21…弾性表面波装置
22…圧電基板
23…多電極型縦結合2重モードSAW共振子フィルタ
24…並列腕共振子
25，27，29…入力側IDT
26，28…出力側IDT
30，31…反射器
32a～32d…IDT
33…入力端子
34…接続点
35…出力端子
41…弾性表面波装置
42…圧電基板
43…多電極型縦結合2重モードSAW共振子フィルタ
44…並列腕共振子
60…直列腕共振子
61…IDT
62，63…反射器
81…弾性表面波装置
82…圧電基板
83…多電極型縦結合2重モードSAW共振子フィルタ
84…並列腕共振子

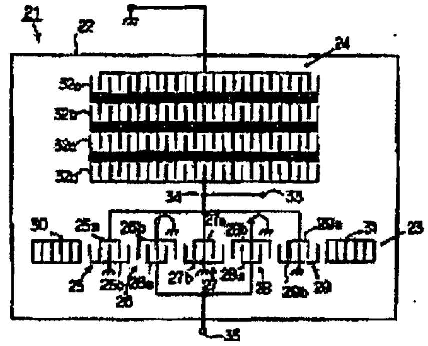
85…直列腕共振子

86…第2の並列腕共振子

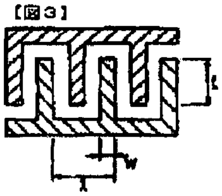
【図1】



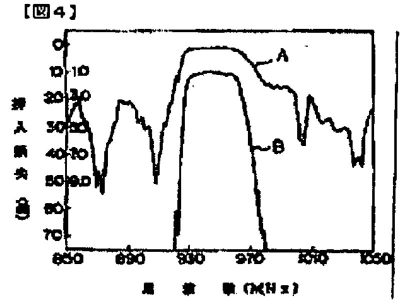
【図2】



【図3】



【図4】



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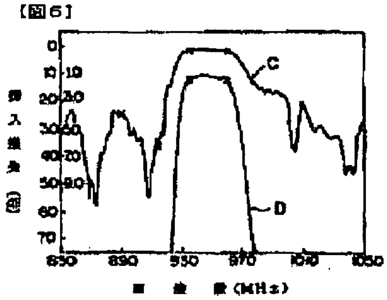
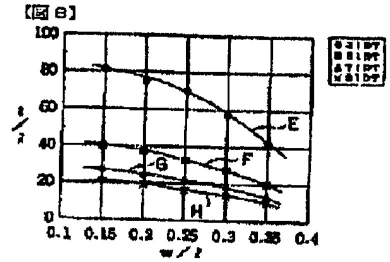
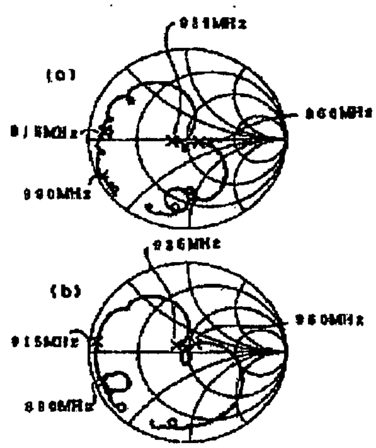


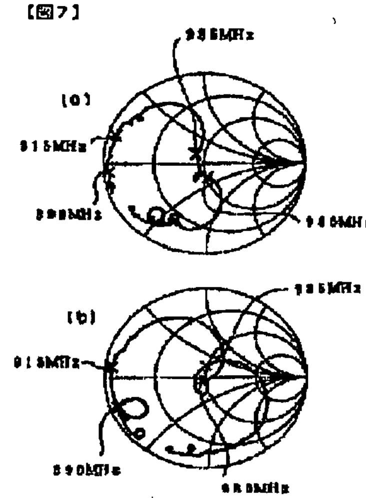
【図8】



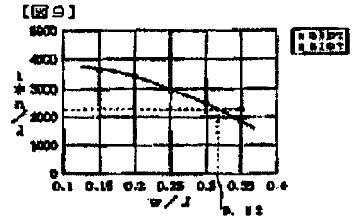
【図5】



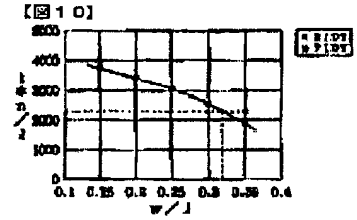
【図7】



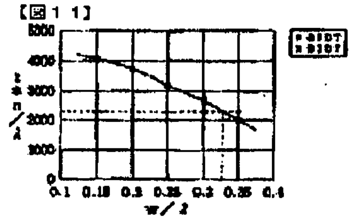
【図9】



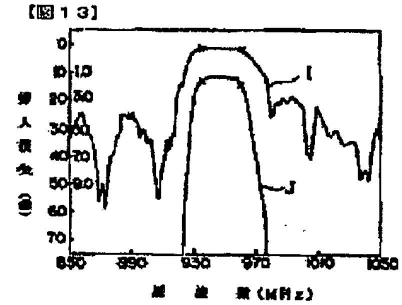
【図10】



【図11】



【図13】



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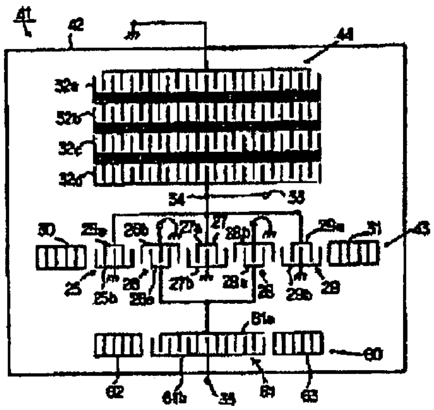
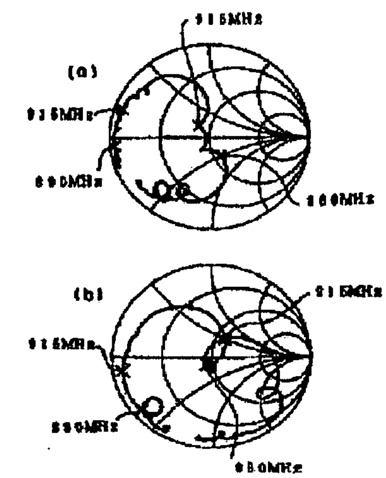
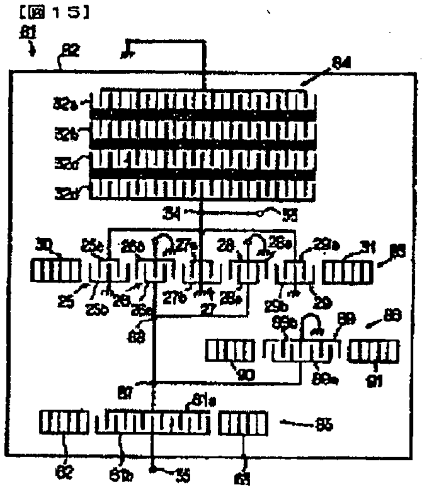


【図14】



【図15】



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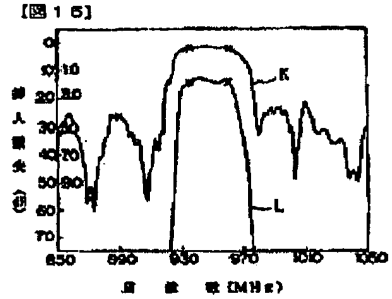
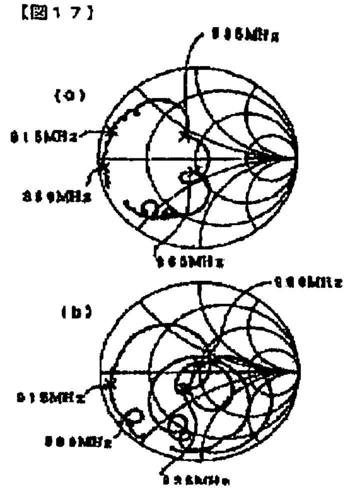
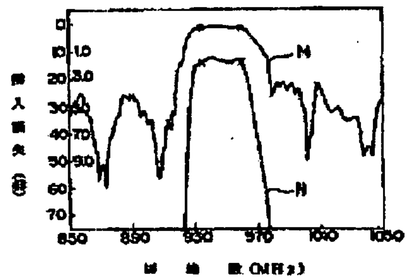


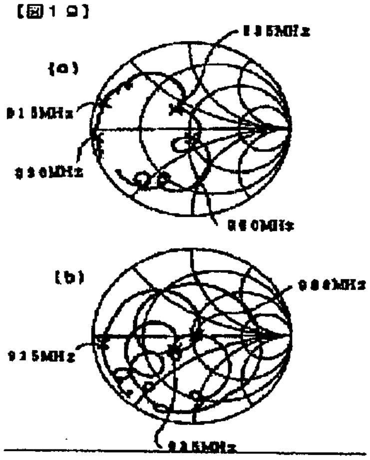
【図17】



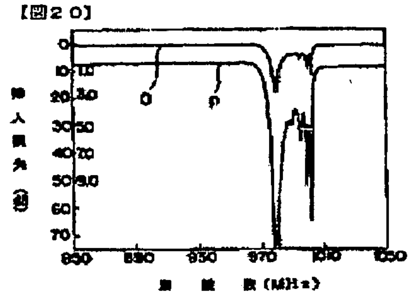
【図18】



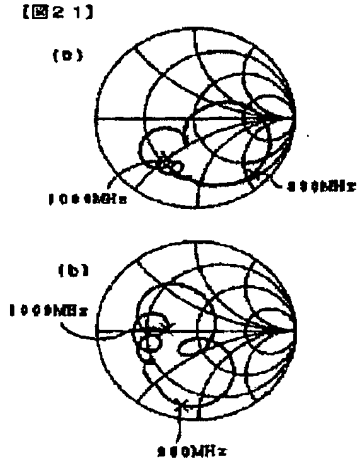
【図19】



【図20】



【図21】



CLAIMS

[Claim(s)]
[Claim 1] The surface wave substrate which has a piezo-electric substrate or a piezo-electric thin film, The reflector of the pair arranged at the surface wave propagation direction both sides of the field in which five or more INTADEJITARUTORANSUDEYUSA and said INTADEJITARUTORANSUDEYUSA currently formed so that said piezo-electric substrate top or said piezo-electric thin film may be touched are prepared It does not have the many electrode type length joint duplex mode SAW resonator filter which it has, and a reflector. And it has the juxtaposition arm resonator which consists of a 1 terminal-pair SAW resonator by which parallel connection was carried out to said SAW resonator filter so that resonance frequency might be located in a low frequency side rather than the passband of said SAW resonator filter. Surface acoustic wave equipment with which an input side edge child is characterized by being the node of said SAW resonator filter and said juxtaposition arm resonator.
[Claim 2] Said many electrode type length joint duplex mode SAW resonator filter Have five or more INTADEJITARUTORANSUDEYUSA [odd] and INTADEJITARUTORANSUDEYUSA of this odd number individual is made into input-side INTADEJITARUTORANSUDEYUSA or output side INTADEJITARUTORANSUDEYUSA by turns along the surface-wave propagation direction. A number containing two INTADEJITARUTORANSUDEYUSA nearest to the reflector of said pair of the electrode finger of input-side INTADEJITARUTORANSUDEYUSA of total Surface acoustic wave equipment according to claim 1 by which it is made [more] than total of the number of the electrode fingers of output side INTADEJITARUTORANSUDEYUSA, and said juxtaposition arm resonator is connected to said input-side INTADEJITARUTORANSUDEYUSA.
[Claim 3] said piezo-electric substrate -- 36 degreeY cut X propagation $LiTaO_3$ a substrate constitutes -- having -- **** -- and the ratio of the width of face w of the electrode finger of said INTADEJITARUTORANSUDEYUSA, and the wavelength lambda of a surface wave -- surface acoustic wave equipment according to claim 2 with which w/lambda is set to w/lambda <=0.32.
[Claim 4] Surface acoustic wave equipment according to claim 2 further equipped with at least one serial arm resonator which consists of 1 terminal-pair SAW resonators connected so that it might connect with said output side INTADEJITARUTORANSUDEYUSA and the antiresonant frequency might consist of a passband of said SAW resonator filter a high-frequency side.
[Claim 5] The surface wave substrate which has a piezo-electric substrate or a piezo-electric thin film, The reflector arranged at the surface wave propagation direction both sides of the field in which five or more INTADEJITARUTORANSUDEYUSA [odd] and this INTADEJITARUTORANSUDEYUSA which are formed so that said piezo-electric substrate top or said piezo-electric thin film may be touched are prepared It does not have the many electrode type length joint duplex mode SAW resonator filter which it has, and a reflector. And the 1st juxtaposition arm resonator which consists of a 1 terminal-pair SAW resonator by which parallel connection was carried out to the SAW resonator filter so that resonance frequency might be located in the frequency domain by the side of low frequency rather than the passband of said SAW resonator filter, It has at least one serial arm resonator which consists of 1 terminal-pair SAW resonators connected so that it might connect with said output side INTADEJITARUTORANSUDEYUSA and the antiresonant frequency might consist of a passband of said SAW resonator filter a high-frequency side. In said SAW resonator filter, a number containing two INTADEJITARUTORANSUDEYUSA nearest to the reflector of a pair of the electrode finger of input-side INTADEJITARUTORANSUDEYUSA of total It is made [more] than total of the number of the electrode fingers of

output side INTADEJITARUTORANSUDEYUSA. And said 1st juxtaposition arm resonator is connected to said input-side INTADEJITARUTORANSUDEYUSA. And it sets to the manufacture approach of surface acoustic wave equipment that the 2nd juxtaposition arm resonator is connected so that the resonance frequency may become said output side INTADEJITARUTORANSUDEYUSA from the antiresonant frequency of said serial arm resonator a high-frequency side. The manufacture approach of the surface acoustic wave equipment characterized by connecting said at least one serial arm resonator after connecting said 2nd juxtaposition arm resonator.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to amelioration of the surface acoustic wave equipment especially constituted using the many electrode type length joint duplex mode SAW resonator filter about the surface acoustic wave equipment used as a band-pass filter.
[0002]
[Description of the Prior Art] In various communication equipment, such as a mobile transmitter, surface acoustic wave equipment is used abundantly as a band-pass filter. By the way, with the surface acoustic wave equipment used as a band-pass filter in the receiving side of the antenna top of a cellular phone, it is low loss and it is called for that the magnitude of attenuation outside a passband is large.
[0003] Then, the surface acoustic wave equipment with which expansion of the magnitude of attenuation in an inhibition zone is achieved by the reduction list of VSWR in low-loss-izing and a passband (standing-wave ratio) is indicated by JP,6-97525,A.
[0004] The electrode structure of surface acoustic wave equipment given in this advanced technology is shown in drawing 1 . The 3 electrode mold SAW resonator filter 1, the serial arm resonator 2, and the juxtaposition arm resonator 3 consist of this surface acoustic wave equipment on the piezo-electric substrate.
[0005] The SAW resonator filter 1 has three INTADEJITARUTORANSUDEYUSA (following, IDT) 4-6 to a central field. IDT 4-6 consists of comb mold electrodes 4a, 4b, 5a, 5b, 6a, and 6b of a pair, respectively. Reflectors 7 and 8 are arranged at the surface wave propagation direction both sides of the field in which IDT 4-6 is formed. Moreover, it is IDT 4 and 6, while it goes away, and common connection of the mold electrodes 4a and 6a is made, and they are connected at the node 9. The serial arm resonator 2 is connected between this node 9 and an input terminal 10. The serial arm resonator 2 has the structure which has arranged reflectors 12 and 13 on both sides of IDT11.
[0006] Moreover, it is an output side IDT5, while it goes away and mold electrode 5a is connected at the node 14. The node 14 is connected to the output terminal 15. Moreover, the juxtaposition arm resonator 3 is connected between a node 14 and ground potential. The juxtaposition arm resonator 3 has the reflectors 17 and 18 arranged at the both sides of IDT16 and IDT16.
[0007] It goes away SAW resonator filter 1, and the mold electrodes 4b, 5b, and 6b are connected to ground potential, respectively. Moreover, this serial arm resonator 2 is connected so that the resonance frequency of the above-mentioned serial arm resonator 2 may be located in the passband of the SAW resonator filter 1, and parallel connection of this juxtaposition arm resonator 3 is carried out so that the antiresonant frequency of the juxtaposition arm resonator 3 may be located in the passband of the SAW resonator filter 1.
[0008] With the above-mentioned surface acoustic wave equipment, namely, the inside of three IDT(s) 4-6 of the 3 electrode type length joint duplex mode SAW resonator filter 1, By carrying out series connection of the serial arm resonator 2 to outside IDT 4 and 6 so that resonance frequency may be located in the passband of the SAW resonator filter 1 With the impedance-frequency characteristics of this serial arm resonator, reduction of VSWR by the side of IDT4 of the outside of the SAW resonator filter 1 and 6 is achieved, and the magnitude of attenuation especially in the decay area by the side of high frequency outside a passband is expanded. Moreover, expansion of the magnitude of attenuation especially in the decay area by the side of low frequency is achieved by the reduction list of VSWR by the side of IDT5 of the center of the SAW resonator filter 1 passband outside with the impedance-frequency characteristics

of this juxtaposition arm resonator 3 by carrying out parallel connection of the above-mentioned juxtaposition arm resonator 3 to IDT5 of the center of the above-mentioned SAW resonator filter so that the antiresonant frequency may be located in the passband of the SAW resonator filter 1.

[0009]

[Problem(s) to be Solved by the Invention] With the surface acoustic wave equipment mentioned above, expansion of the magnitude of attenuation in the decay area outside a passband is achieved by the reduction list of löss by connecting the serial arm resonator 2 and the juxtaposition arm resonator 3 to the 3 electrode type length joint duplex mode SAW resonator filter 1 as mentioned above.

[0010] On the other hand, at the antenna top of a cellular phone etc., the big power from a transmitting side is impressed to the inhibition zone (passband of a transmitting side) of the receiving-side (Rx side) filter. When large power was not able to be borne from a transmitting side when the above-mentioned surface acoustic wave equipment is used, for example, the power which is 2W was impressed as such a receiving-side filter, there was a problem of destroying in an instant.

[0011] Moreover, in using the above-mentioned surface acoustic wave equipment as a receiving-side filter of the antenna top for cellular phones, it has connected with the transmitting-side filter which sets up so that the impedance of an inhibition zone may be opened using a stripline etc., for example, consists of a filter using a dielectric resonator, or an SAW filter. However, although it was desired for the reflection coefficient of the receiving-side filter in the passband of a transmitting side to be large in order to have controlled loss of a transmitting side in this case, with the above-mentioned surface acoustic wave equipment, the reflection coefficient in the passband of a transmitting side could not fully be raised.

[0012] In addition, the magnitude of attenuation in the decay area by the side of high frequency is not more enough than a passband as a general description of a SAW resonator filter, therefore expansion of the magnitude of attenuation in the decay area by the side of high frequency is called for strongly.

[0013] This invention cancels the fault of the conventional surface acoustic wave equipment mentioned above, is low loss, and it not only can expand the magnitude of attenuation in the decay area by the side of low frequency rather than a passband, but is excellent in power-proof nature, and it aims at offering the surface acoustic wave equipment to which the magnitude of attenuation of the decay area by the side of high frequency is further expanded rather than the passband.

[0014]

[The means for solving a technical problem and an effect of the invention] Accomplish this invention in order to attain the above-mentioned technical problem, and according to the large aspect of affairs of this invention The surface wave substrate which has a piezo-electric substrate or a piezo-electric thin film, It does not have the many electrode type length joint duplex mode SAW resonator filter which has the reflector of the pair arranged at the surface wave propagation direction both sides of the field in which five or more IDT(s) currently formed so that said piezo-electric substrate top or said piezo-electric thin film may be touched, and said IDT are prepared, and a reflector. And it has the juxtaposition arm resonator which consists of a 1 terminal-pair SAW resonator by which parallel connection was carried out to said SAW resonator filter so that resonance frequency might be located in a low frequency side rather than the passband of said SAW resonator filter. The surface acoustic wave equipment with which an input side edge child is characterized by being the node of said SAW resonator filter and said juxtaposition arm resonator is offered.

[0015] Since parallel connection of the above-mentioned juxtaposition arm resonator is carried out to the many electrode type length joint duplex mode SAW resonator filter by the above-mentioned relation according to this invention, the power impressed from an input terminal will be distributed by a SAW resonator filter and the juxtaposition arm resonator, and power-proof nature is effectively raised by it.

[0016] Moreover, since the above-mentioned juxtaposition arm resonator is prepared so that the resonance frequency may be located in the field by the side of low frequency rather than the passband of a SAW resonator filter, the magnitude of attenuation in the decay area by the side of the low frequency of a passband is raised. In addition, the reflection coefficient in an inhibition zone is also raised so that clearly from explanation of the below-mentioned operation gestalt.

[0017] Moreover, on the specific aspect of affairs of this invention, the above-mentioned many electrode type length joint duplex mode SAW resonator filter has five or more IDT(s) [odd], and let IDT of this odd number individual by turns be an input side IDT or an output side IDT along the surface wave propagation direction. In this case, let two IDT

(s) nearest to the reflector of the above-mentioned pair be input sides IDT. Moreover, a number containing two IDT(s) nearest to the reflector of this pair of the electrode finger of an input side IDT of total is made [more] than total of the number of the electrode fingers of an output side IDT, and the above-mentioned juxtaposition arm resonator is connected to the input side IDT.
[0018] With the surface acoustic wave equipment offered according to this specific aspect of affairs In the operation effectiveness of the surface acoustic wave equipment offered according to the large aspect of affairs of above-mentioned this invention, in addition, since the number of input sides IDT increases more than the number of output sides IDT, Namely, since the input side IDT and the output side IDT are arranged by turns along the surface wave propagation direction so that two IDT(s) nearest to the reflector of a pair may serve as an input side IDT, The electrode finger gross area of IDT of the side to which power is impressed becomes large, therefore the power-proof nature in an input side edge child's inhibition zone can be raised further.
[0019] moreover -- the still more specific aspect of affairs of this invention -- as a piezo-electric substrate -- 36 degreeY cut X propagation $LiTaO_3$ a substrate uses -- having -- the ratio of the width of face w of the electrode finger of IDT, and the wavelength lambda of a surface wave -- w/lambda is set to w/lambda <=0.32. In this case, 36 degreeY cut X propagation $LiTaO_3$ with a large and electromechanical coupling coefficient and the temperature characteristic good as a piezo-electric substrate Since the substrate is used, the temperature characteristic can offer easily the surface acoustic wave equipment which has sufficient bandwidth good. In addition, since the ratio of the width of face w of the electrode finger of IDT and the wavelength lambda of a surface wave is made or less into 0.32 as mentioned above, In the configuration which constituted five or more IDT(s) [odd] so that clearly from explanation of the below-mentioned operation gestalt A large number can come out relatively, the electrode finger gross area of a certain input side IDT can be relatively enlarged further compared with the electrode finger gross area of an output side IDT, and it can raise power-proof nature further.
[0020] In this invention, at least one serial arm resonator which consists of 1 terminal-pair SAW resonators so that antiresonant frequency may consist of a passband of a SAW resonator filter a high-frequency side is connected to an output side IDT in the configuration which has five or more IDT(s) [odd] preferably offered according to the specific aspect of affairs of above-mentioned this invention. With the configuration which connected at least one serial arm resonator further, the magnitude of attenuation in the decay area by the side of high frequency may be effectively increased rather than a passband, without spoiling not only the reflection coefficient in power-proof nature and an inhibition zone but a phase.
[0021] Moreover, the surface wave substrate which has a piezo-electric substrate or a piezo-electric thin film on another aspect of affairs of this invention, The reflector arranged at the surface wave propagation direction both sides of the field in which five or more INTADEJITARUTORANSUDEYUSA [odd] and this INTADEJITARUTORANSUDEYUSA which are formed so that said piezo-electric substrate top or said piezo-electric thin film may be touched are prepared It does not have the many electrode type length joint duplex mode SAW resonator filter which it has, and a reflector. And the 1st juxtaposition arm resonator which consists of a 1 terminal-pair SAW resonator by which parallel connection was carried out to the SAW resonator filter so that resonance frequency might be located in the frequency domain by the side of low frequency rather than the passband of said SAW resonator filter, It has at least one serial arm resonator which consists of 1 terminal-pair SAW resonators connected so that it might connect with said output side INTADEJITARUTORANSUDEYUSA and the antiresonant frequency might consist of a passband of said SAW resonator filter a high-frequency side. In said SAW resonator filter, a number containing two INTADEJITARUTORANSUDEYUSA nearest to the reflector of a pair of the electrode finger of input-side INTADEJITARUTORANSUDEYUSA of total It is made [more] than total of the number of the electrode fingers of output side INTADEJITARUTORANSUDEYUSA. And said 1st juxtaposition arm resonator is connected to said input-side INTADEJITARUTORANSUDEYUSA. And it sets to the manufacture approach of surface acoustic wave equipment that the 2nd juxtaposition arm resonator is connected so that the resonance frequency may become said output side INTADEJITARUTORANSUDEYUSA from the antiresonant frequency of said serial arm resonator a high-frequency side. After connecting said 2nd juxtaposition arm resonator, the manufacture approach of the surface acoustic wave equipment characterized by connecting said at least one serial arm resonator is offered. According to this manufacture approach, in addition to the operation effectiveness of the surface acoustic wave equipment of this invention mentioned above, the magnitude of attenuation is further expandable to a high-frequency side over a larger frequency range from a passband.

[0022]
[Embodiment of the Invention] This invention is clarified by explaining the operation gestalt [un-limit] of this invention hereafter.
[0023] The 1st operation gestalt drawing 2 is the schematic-drawing-top view of the surface acoustic wave equipment concerning the 1st operation gestalt of this invention.
[0024] Surface acoustic wave equipment 21 is constituted using the piezo-electric substrate 22. The piezo-electric substrate 22 is the 36 degreeY cut X propagation LiTaO3. It consists of a substrate. The many electrode type length joint duplex mode SAW resonator filter 23 and the juxtaposition arm resonator 24 are constituted by forming the below-mentioned various electrodes on the piezo-electric substrate 22.
[0025] That is, five IDT(s) 25-29 are arranged along the surface wave propagation direction in the SAW resonator filter 23 on the piezo-electric substrate 22. IDT 25, 27, and 29 is an input side IDT among IDT(s) 25-29, and IDT 26 and 28 is an output side IDT. Each IDT 25-29 has the comb mold electrodes 25a, 25b-29a of a pair, and 29b, respectively. Reflectors 30 and 31 are formed in the surface wave propagation direction outside of the field in which IDT 25-29 is formed. Reflectors 30 and 31 are constituted by the grating reflector which has two or more electrode fingers.
[0026] Moreover, the juxtaposition arm resonator 24 is constituted by the 1 terminal-pair SAW resonator, and has the configuration which comes to connect five IDT(s) 32a-32d with a serial. Each IDT(s) 32a-32d are constituted by the comb mold electrode of the pair which has two or more electrode fingers put mutually in between, respectively. Moreover, all the logarithms of IDT(s) [32a-32d] opening length and an electrode finger are made the same.
[0027] the resonance frequency is a low frequency side, and the juxtaposition arm resonator 24 consists of a passband of the SAW resonator filter 23 a high-frequency side rather than an inhibition zone especially -- as -- an input side IDT25 -- it goes away 29 and connects with the mold electrodes 25a and 29a electrically. That is, while the 1st comb mold electrode 25a, 27a, and 29a of the input side 25, 27, and IDT 29 of the SAW resonator filter 23 is connected at the node 34 connected to the input terminal 33, the juxtaposition arm resonator 24 is connected at this node 34. The terminal of the opposite side of the juxtaposition arm resonator 24 is connected to ground potential. Moreover, the 2nd comb mold electrode 25b, 27b, and 29b of the input side 25, 27, and IDT 29 of the SAW resonator filter 23 is also connected to ground potential.
[0028] Moreover, common connection of the 1st comb mold electrode 26a and 28a of an output side 26 and IDT 28 is made, and it is connected to the output terminal 35. The 2nd comb mold electrode 26b and 28b of IDT 26 and 28 is connected to ground potential, respectively.
[0029] The magnitude-of-attenuation frequency characteristics of the above-mentioned SAW resonator filter 23 are shown in drawing 4 . In addition, in drawing 4 , the property shown as a continuous line B is a property which expanded the insertion loss of an axis of ordinate to the scale on the right-hand side of an axis of ordinate, and showed the important section of the property shown as a continuous line A.
[0030] Moreover, the impedance Smith chart of the above-mentioned SAW resonator filter 23 is shown in drawing 5 (a) and (b). In addition, drawing 5 (a) is the property as which drawing 5 (b) regarded the property seen from the terminal by the side of IDT 25 and 27 and 29 from the terminal by the side of IDT26 and 28. In addition, the passband of the above-mentioned SAW resonator filter 23 is 935-960MHz, and the inhibition zone by the side of low frequency is 890-915MHz.
[0031] Although the juxtaposition arm resonator 24 is connected to the above-mentioned SAW resonator filter 23 as mentioned above with the surface acoustic wave equipment 21 of this operation gestalt as mentioned above, the magnitude-of-attenuation frequency characteristics of passband inside and outside as the whole are shown in drawing 6 . In addition, in drawing 6 , a continuous line D is the property which expanded the insertion loss of an axis of ordinate on the scale on the right-hand side of an axis of ordinate, and showed the important section of the property shown as the continuous line C.
[0032] In the property shown in drawing 6 so that clearly, if drawing 4 was compared with drawing 6 , it turns out that the magnitude of attenuation is large near the passband in the field by the side of low frequency rather than the passband. That is, according to this operation gestalt, by connecting the above-mentioned juxtaposition arm resonator 24 to the SAW resonator filter 23 as mentioned above shows that the magnitude of attenuation is especially raised for the magnitude of attenuation in the low frequency side field outside a passband effectively in the high-frequency side field in the above-mentioned inhibition zone.
[0033] Moreover, drawing 7 (a) and (b) show the impedance Smith chart of the surface acoustic wave equipment 21 of

this operation gestalt, and (a) shows the property as which (b) regarded the property seen from the input terminal from the output terminal. If the property shown in drawing 5 (a) is compared with the property shown in drawing 7 (a), it turns out that the reflection coefficient [in / in the direction of the property shown in drawing 7 (a) / an inhibition zone, i.e., the passband of the other party,] is large.

[0034] In addition, with the surface acoustic wave equipment 21 of this operation gestalt, not only IDT 25, 27, and 29 but IDT(s) 32a-32d which constitute the juxtaposition arm resonator 24 are connected to the input terminal 33. Therefore, it turns out that the electrode finger gross area of IDT connected to the input side edge child becomes large to the electrode finger gross area of IDT 5 and 16 in the conventional surface acoustic wave equipment shown in drawing 1 .

[0035] That is, with this operation gestalt, since the above-mentioned juxtaposition arm resonator 24 is connected to the SAW resonator filter 23 by the above-mentioned relation, in the decay area outside a passband, especially the decay area by the side of low frequency, the magnitude of attenuation is expandable. In addition, since the reflection coefficient in an inhibition zone may be made high when it uses as a receiving-side filter, for example in the antenna top of a cellular phone, the loss in the passband of a transmitting side can be controlled effectively.

[0036] Moreover, since the above-mentioned juxtaposition arm resonator 24 was connected, as it mentioned above, since the power impressed from the input terminal is distributed by the SAW resonator filter 23 and the juxtaposition arm resonator 24, power-proof nature is raised.

[0037] By the way, mechanical stress occurs in the electrode of IDT and the destruction at the time of supplying large power to surface acoustic wave equipment is considered that the atom in the electrode which constitutes IDT is because migration starts, when exciting a surface wave.

[0038] Drawing 3 is drawing showing the width of face w of the above-mentioned electrode finger in IDT, the wavelength lambda of a surface wave, and relation with the decussation width of face t. With reference to drawing 3 , the further conditions which can raise power-proof nature are explained.

[0039] For example, with the conventional 3 electrode type length joint duplex mode SAW resonator filter shown in drawing 1 , in order to attain broadband-ization, when the number of the electrode finger of IDT is reduced, in order to set the impedance of I/O to 50 ohms, decussation width of face t of IDT needed to be enlarged, or width of face w of the electrode finger of IDT needed to be enlarged. Therefore, in order to reduce the resistance loss in IDT conventionally, the above-mentioned decussation width of face t was made small, and width of face w of an electrode finger was made thick to 0.35 or more times of wavelength lambda.

[0040] on the other hand -- since five IDT(s) of IDT 25-29 are prepared with the surface acoustic wave equipment 21 of this operation gestalt, even if it is the case where it considers as the same decussation width of face as the case where it is a 3 electrode mold SAW resonator filter -- every -- width of face of the electrode finger in IDT 25-29 can be made thinner than the width of face of the electrode finger in IDT of a 3 electrode mold SAW resonator filter, and an I/O impedance can be considered as 50-ohm pure resistance.

[0041] The invention-in-this-application person changed the number of IDT(s), and investigated the relation of the width of face w of an electrode finger and the decussation width of face t from which an I/O impedance serves as 50-ohm pure resistance. Consequently, the result shown in drawing 8 was obtained. In addition, in the relation shown in drawing 8 , on the basis of the case where the fractional band width in t/lambda =0.25 is as fixed as 4%, fractional band width is asked for the above-mentioned relation as it is fixed.

[0042] In addition, continuous-line E-H of drawing 8 is [-- The relation in the case of 9 electrode molds is shown.] a continuous line E, respectively. -- They are 3 electrode molds and a continuous line F. -- They are 5 electrode molds and a continuous line G. -- They are 7 electrode molds and a continuous line H. clear from drawing 8 -- as -- the decussation width of face t -- case it is the same -- (i.e., a ratio) case t/lambda is equal -- 3 electrode molds -- setting -- a ratio -- a more considerable configuration than w/lambda =0.35 -- 5 electrode molds -- a ratio -- it turns out that it can realize less than [w/lambda =0.15]. That is, in order to attain broadband-ization, when the number of the electrode finger in IDT is reduced, in order to make the impedance during I/O into a predetermined value, with this operation gestalt, it turns out that there is no need of making width of face of an electrode finger thick.

[0043] On the other hand, it turns out that the lifetime which results in a short circuit by inter-electrode migration becomes so long that spacing of the signal line and earth wire in IDT is large. Therefore, with this operation gestalt, when the wavelength lambda of IDT becomes short by RF-ization, since width of face w of an electrode finger can be narrowed as mentioned above, it turns out that power-proof nature can be raised effectively.

[0044] As mentioned above, with this operation gestalt, it not only can raise power-proof nature by the ability making thin width of face w of an electrode finger as mentioned above, but Since the input side IDT is made [many] compared with three IDT(s) 25, 27, and 29 and IDT 26 and 28 of an output side and IDT(s) 32a-32d of the above-mentioned juxtaposition arm resonator 24 are formed further, Since the gross area of the electrode of near IDT with which power is impressed can be made larger than the gross area of the electrode of an output side IDT, it can also raise effectively the power-proof nature in an input side edge child's inhibition zone.

[0045] Although the surface acoustic wave equipment 21 of the operation gestalt of the modification 1st of the 1st operation gestalt was constituted as mentioned above, preferably, the ratio of the width of face w of an electrode finger and the wavelength lambda of a surface wave in IDT 25-29 of the SAW resonator filter 23 of the above-mentioned surface acoustic wave equipment is set to w/lambda <=0.32, and power-proof nature is further raised by it. That is, if electrode finger decussation width of face of IDT in a SAW resonator filter is made small, since an electrode surface product becomes small, power-proof nature will deteriorate. Then, it investigated how total of the electrode finger area of IDT which influences power-proof nature would change with the number of the width of face w and IDT of the electrode finger in the electrode configuration which has various numbers of IDT(s). the case where IDT(s) of drawing 9 - drawing 11 are five pieces, seven pieces, and nine pieces, respectively -- the ratio of the decussation width of face t of an electrode finger, and wavelength lambda -- the value which spent the number n of the electrode finger of an input side 25, 27, and IDT 29 on t/lambda, and a ratio -- it is drawing showing relation with w/lambda. The product of the number n of the decussation width of face t and an electrode finger shows the amount equivalent to the electrode surface product of IDT here, and the total numbers of the electrode finger of the input side IDT in case IDT(s) are five pieces, seven pieces, and nine pieces are n5 =91, n7 =136, and n9 =195, respectively.

[0046] Moreover, with the surface acoustic wave equipment using three conventional IDT(s), as mentioned above, width of face w of an electrode finger was made into 0.35 or more times of wavelength lambda. Then, in drawing 9 - drawing 11 , for the comparison, - mark was attached and the value of txn/lambda in the conventional 3 electrode mold surface acoustic wave equipment in w/lambda =0.35 was shown collectively.

[0047] With the configuration using five or more IDT(s), txn/lambda whose width of face w of an electrode is an amount equivalent to area as the number of IDT(s) increases in a fixed case is large, and the amount of the case where five IDT(s) are used is the smallest so that clearly from drawing 9 - drawing 11 .

[0048] therefore, the case where five or more IDT(s) are used as shown in drawing 9 - drawing 11 -- a ratio -- it turns out that 0.32 or less [then] and the electrode gross area of an input side IDT can be enlarged for w/lambda, and power-proof nature can be raised further.

[0049] The 2nd operation gestalt drawing 12 is a schematic-drawing-top view for explaining the surface acoustic wave equipment concerning the 2nd operation gestalt of this invention. For surface acoustic wave equipment 41, it is constituted using the piezo-electric substrate 42, and the piezo-electric substrate 42 is the 36 degreeY cut X propagation LiTaO3. It consists of a substrate. The many electrode type length joint SAW resonator filter 43, the juxtaposition arm resonator 44, and the serial arm resonator 60 are constituted by forming the below-mentioned various electrodes on the piezo-electric substrate 42.

[0050] The SAW resonator filter 43 and the juxtaposition arm resonator 44 are constituted like the SAW resonator filter 23 and the juxtaposition arm resonator 24 concerning the 1st operation gestalt. Therefore, about the same part, the detailed explanation is omitted by ****** which attaches the same reference number.

[0051] The place where this operation gestalt differs from the 1st operation gestalt is to connect the serial arm resonator 60 to the output side of the SAW resonator filter 43. That is, the serial arm resonator 60 has the reflectors 62 and 63 which consist of a grating reflector arranged on the surface-wave propagation direction outside of IDT61 and IDT61 arranged in the center. IDT61 has the comb mold electrodes 61a and 61b of the pair which has two or more electrode fingers put mutually in between. It is the output side 26 and IDT 28 of the SAW resonator filter 43, while it goes away, and common connection of the mold electrodes 26a and 28a is made, they go away serial arm resonator 60, and are connected to mold electrode 61a.

[0052] Therefore, with the surface acoustic wave equipment 41 concerning the 2nd operation gestalt, the input side 25, 27, and IDT 29 of the SAW resonator filter 43 is connected with the juxtaposition arm resonator 44 at the node 34 connected to the input terminal 33. On the other hand, the output side 26 and IDT 28 is connected to the output terminal 35 through the serial arm resonator 60. In addition, the passband of the SAW resonator filter 43 is 935-960MHz like the case of the 1st operation gestalt, and an inhibition zone is 890-915MHz.

[0053] The juxtaposition arm resonator 44 is connected to IDT 25, 27, and 29 so that the resonance frequency may serve as a field by the side of low frequency from the above-mentioned inhibition zone rather than the field and passband by the side of high frequency. Moreover, the serial arm resonator 60 is connected to IDT 26 and 28 so that the antiresonant frequency may be located in the decay area by the side of high frequency rather than the passband of the SAW resonator filter 43.
[0054] The magnitude-of-attenuation frequency characteristics of passband inside and outside as the whole surface acoustic wave equipment 41 of this operation gestalt are shown in drawing 13 . In addition, the continuous line J of drawing 13 is a property which the insertion loss of an axis of ordinate is expanded on the scale on the right-hand side of an axis of ordinate, and shows the important section of the property shown as the continuous line I.
[0055] If the magnitude-of-attenuation frequency characteristics shown in drawing 13 are compared with drawing 6 which is the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment of the 1st operation gestalt, with the surface acoustic wave equipment 41 of this operation gestalt, it turns out that the magnitude of attenuation is large also in the decay area by the side of high frequency rather than the passband so that clearly. That is, it turns out the magnitude of attenuation in the frequency domain by the side of the high frequency of the area within the above-mentioned inhibition is not only expanded, but that the magnitude of attenuation becomes large in the decay area by the side of high frequency rather than a passband.
[0056] That is, with surface acoustic wave equipment 41, first, since the juxtaposition arm resonator 44 is connected to the input side 25, 27, and IDT 29 so that the resonance frequency may serve as a frequency domain by the side of the high frequency of an inhibition zone, the magnitude of attenuation in the frequency domain by the side of the low frequency outside a passband, especially the frequency domain by the side of the high frequency of the area within inhibition is expanded to the SAW resonator filter 43.
[0057] Moreover, the power impressed to an input terminal 16 will be distributed by the input side 25, 27, and IDT 29 and the juxtaposition arm resonator 44 of the SAW resonator filter 43, and power-proof nature is raised by connection of the above-mentioned juxtaposition arm resonator 44. In addition, since five IDT(s) 25-29 are formed and the input side IDT is constituted from the SAW resonator filter 43 by three IDT(s) 25, 27, and 29, By connecting the juxtaposition arm resonator 44 which are many pairs and comes to carry out series connection of two or more steps of IDT(s) to a list, since power is impressed to the input side IDT with many numbers of an electrode finger The gross area of the electrode of IDT with which power is impressed is expanded, and the power-proof nature in an input side edge child's inhibition zone is raised by it.
[0058] In addition, expansion of the magnitude of attenuation in the decay area by the side of high frequency is also achieved rather than a passband, without spoiling an input side edge child's power-proof nature and reflection coefficient in an inhibition zone which were mentioned above, since the above-mentioned serial arm resonator is connected so that the antiresonant frequency may be located in the decay area by the side of high frequency rather than the passband of the SAW resonator filter 43.
[0059] In addition, with this operation gestalt, although one serial arm resonator 60 was used, when you may connect between the output terminal 35 and the SAW resonator filter 43 and two or more serial arm resonators connect more serial arm resonators, the magnitude of attenuation in the frequency domain by the side of high frequency can be further expanded rather than a passband.
[0060] Moreover, in using surface acoustic wave equipment 41 as an antenna common machine of a cellular phone with which a part of decay area by the side of low frequency turns into an inhibition zone (namely, passband of the other party) from a passband, in order to raise the impedance of an inhibition zone, it is necessary to rotate the phase of the impedance in an input terminal. Since a phase will turn conversely to the hand of cut of a phase when a serial arm resonator is connected to an input terminal, the long phase machine of track length is needed. However, if the track length of a phase machine is lengthened, the loss in a phase machine will become large, and the size of a phase machine will also become large. On the other hand, with this operation gestalt, expansion of the magnitude of attenuation in the decay area by the side of high frequency can be aimed at rather than a passband as mentioned above, without having effect of the phase on the impedance in an input terminal 33, since the serial arm resonator 60 is connected to the output side.
[0061] The 3rd operation gestalt drawing 15 is a schematic-drawing-top view for explaining the surface acoustic wave equipment concerning the 3rd operation gestalt of this invention. For surface acoustic wave equipment 81, it is constituted using the piezo-electric substrate 82, and the piezo-electric substrate 82 is the 36 degreeY cut X propagation

LiTaO3. It consists of a substrate.
[0062] The 5 electrode type length joint duplex mode SAW resonator filter 83, the juxtaposition arm resonator 84, the serial arm resonator 85, and the 2nd juxtaposition arm resonator 86 are constituted by forming the various below-mentioned electrodes on the piezo-electric substrate 82. But the SAW resonator filter 83 and the juxtaposition arm resonator 84 are constituted like the SAW resonator filter 23 of the surface acoustic wave equipment 21 of the 1st operation gestalt, and the juxtaposition arm resonator 24. Moreover, the serial arm resonator 85 is constituted like the serial arm resonator 60 used with the surface acoustic wave equipment of the 2nd operation gestalt. Therefore, about the same part, detailed explanation is omitted by ****** which attaches the same reference number.
[0063] The point that the surface acoustic wave equipment 81 of this operation gestalt differs from the surface acoustic wave equipment 42 concerning the 2nd operation gestalt has the 2nd juxtaposition arm resonator 86 in connecting at the node 87 further. That is, common connection of the output side 26 and IDT 28 of the SAW resonator 83 is made, it connects at the node 88, and the 2nd juxtaposition arm resonator 86 is connected between the node 87 between this node 88 and the serial arm resonator 85, and ground potential.
[0064] The 2nd juxtaposition arm resonator 86 has the reflectors 90 and 91 formed in the surface wave propagation direction both sides of IDT89 and IDT89 which consist of comb mold electrodes 89a and 89b of a pair.
[0065] Therefore, with surface acoustic wave equipment 81, the juxtaposition arm resonator 84 is connected between the nodes 34 and ground potentials which are connected to an input terminal 33, and the SAW resonator filter 83 and the serial arm resonator 85 are connected between the node 34 and the output terminal 35, and it has the configuration to which the 2nd juxtaposition arm resonator 86 was further connected between the output side of a node 87 83, i.e., a SAW resonator filter, and ground potential.
[0066] In the above-mentioned configuration, like the case of the 1st operation gestalt, parallel connection of the resonance frequency of the juxtaposition arm resonator 84 is carried out to the SAW resonator filter 83 so that it may be located in a low frequency side rather than the passband of the SAW resonator filter 83, and resonance frequency may be especially located in the high-frequency side of an inhibition zone also in the decay area by the side of low frequency.
[0067] Moreover, like the case of the surface acoustic wave equipment 41 of the 2nd operation gestalt, the serial arm resonator 85 is connected so that the antiresonant frequency may be located in the decay area by the side of high frequency rather than the passband of the SAW resonator filter 83.
[0068] On the other hand, after constituting the 2nd juxtaposition arm resonator 86 so that the resonance frequency may consist of antiresonant frequency of the serial arm resonator 85 a high-frequency side, and connecting the 2nd juxtaposition arm resonator 86, the serial arm resonator 85 is connected.
[0069] In addition, like the SAW resonator filters 23 and 43 which used the above-mentioned SAW resonator filter 83 with the 1st and 2nd operation gestalt, a passband is 935-960MHz and an inhibition zone is 890-915MHz.
[0070] The magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment 81 concerning the 3rd operation gestalt are shown in drawing 16 . The continuous line L in drawing 16 is a property which the insertion loss of an axis of ordinate is expanded on the scale on the right-hand side of an axis of ordinate, and shows the important section of the property shown as the continuous line K. Moreover, drawing 17 (a) and (b) show the impedance Smith chart of the terminal of the side containing IDT 25 and 29 of two outsides, and the terminal of the opposite side, respectively.
[0071] If drawing 16 is compared with drawing 13 which is the magnitude-of-attenuation frequency characteristics of the 2nd operation gestalt, with the surface acoustic wave equipment 81 of this operation gestalt, the damping property in the frequency domain by the side of high frequency will be further improved rather than a passband so that clearly. That is, it turns out that the big magnitude of attenuation is secured from a passband over a larger frequency range in the frequency domain by the side of high frequency. This is explained to a detail with reference to drawing 18 - drawing 21 .
[0072] When drawing 18 constitutes the surface acoustic wave equipment 81 shown in drawing 15 , the frequency characteristics at the time of connecting the serial arm resonator 85 first and connecting the 2nd juxtaposition arm resonator 86 after an appropriate time are shown, and drawing 19 (a) and (b) show the impedance Smith chart in that case. In addition, in drawing 18 , a continuous line N is a property which the insertion loss of an axis of ordinate is expanded on the scale on the right-hand side of an axis of ordinate, and shows the important section of the property shown as the continuous line M. Moreover, drawing 19 (a) and (b) show the impedance Smith chart of the terminal of

the side containing IDT 25 and 29 of two outsides, and the terminal of the opposite side, respectively. If drawing 18 is compared with drawing 16 , it turns out that the magnitude of attenuation in the decay area by the side of high frequency is small rather than the passband so that clearly.
[0073] Moreover, drawing 20 shows the magnitude-of-attenuation frequency characteristics as the overall characteristic of the serial arm resonator 85 and the 2nd juxtaposition arm resonator 86 which were shown in drawing 15 . In drawing 20 , a continuous line P shows the property which expanded and showed the property shown as the continuous line O about the insertion loss of an axis of ordinate on the scale shown in the right-hand side of an axis of ordinate. Moreover, drawing 21 (a) and (b) show the impedance Smith chart by the side of a serial arm resonator, and the impedance Smith chart by the side of a juxtaposition arm resonator, respectively. The passband of drawing 7 (b) shows that the magnitude of attenuation differs in near 980MHz with drawing 21 (a) to the impedance in a high-frequency side, for example, near 980MHz, and impedance matching of (b).
[0074] Moreover, since the impedance of drawing 21 (b) serves as mismatching from the passband of drawing 7 (b) more by 50-ohm system to the impedance in the frequency domain by the side of high frequency, it turns out that the magnitude of attenuation becomes large.
[0075] Therefore, in connecting the above-mentioned serial arm resonator 85 and the 2nd juxtaposition arm resonator 86 to the SAW resonator filter 83, it turns out by connecting in order of the 2nd juxtaposition arm resonator 86 and the serial arm resonator 85 that the magnitude of attenuation can be effectively expanded over a larger frequency range in the frequency domain by the side of high frequency rather than a passband.
[0076] In addition, with the surface acoustic wave equipment 81 of the 3rd operation gestalt, except having connected the juxtaposition arm resonator 86 of the above 2nd, and connecting the 2nd juxtaposition arm resonator 86 to a list in front of the serial arm resonator 85, since it is the same as that of the surface acoustic wave equipment of the 2nd operation gestalt, similarly the operation effectiveness in the surface acoustic wave equipment 41 of the 2nd operation gestalt can also be acquired.
[0077] That is, the magnitude of attenuation in the frequency domain by the side of low frequency, especially the frequency domain by the side of the high frequency of an inhibition zone is secured to sufficient magnitude from a passband like the case of the surface acoustic wave equipment of the 2nd operation gestalt, and it has sufficient power-proof nature, and the phase of the power-proof nature in an input side edge child's inhibition zone, a reflection coefficient, and an impedance is not spoiled.
[0078] in addition, the 1- mentioned above -- the 3rd operation gestalt -- as a piezo-electric substrate -- the above-mentioned 36 degreeY cut X propagation LiTaO3 although the substrate was used -- other piezo-electric substrates 3, for example, LiNbO, The substrate which may use the piezo-electric substrate which consists of Xtal etc., or consists of electrostrictive ceramics like the titanic-acid lead zirconate system ceramics may be used. Furthermore, the surface wave substrate which comes to form a piezo-electric thin film on an insulating substrate or a piezo-electric substrate may be used. as the above-mentioned piezo-electric thin film -- ZnO and Ta 2O5 etc. -- from -- what becoming can be mentioned.
[0079] Moreover, what is necessary is just to form IDT and a reflector using aluminum and aluminum alloy which are commonly used in surface wave equipment, although it can form with a proper conductive ingredient.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention] This invention relates to amelioration of the surface acoustic wave equipment especially constituted using the many electrode type length joint duplex mode SAW resonator filter about the surface acoustic wave equipment used as a band-pass filter.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In various communication equipment, such as a mobile transmitter, surface acoustic wave equipment is used abundantly as a band-pass filter. By the way, with the surface acoustic wave equipment used as a band-pass filter in the receiving side of the antenna top of a cellular phone, it is low loss and it is called for that the magnitude of attenuation outside a passband is large.
[0003] Then, the surface acoustic wave equipment with which expansion of the magnitude of attenuation in an inhibition zone is achieved by the reduction list of VSWR in low-loss-izing and a passband (standing-wave ratio) is indicated by JP,6-97525,A.
[0004] The electrode structure of surface acoustic wave equipment given in this advanced technology is shown in drawing 1 . The 3 electrode mold SAW resonator filter 1, the serial arm resonator 2, and the juxtaposition arm resonator 3 consist of this surface acoustic wave equipment on the piezo-electric substrate.
[0005] The SAW resonator filter 1 has three INTADEJITARUTORANSUDEYUSA (following, IDT) 4-6 to a central field. IDT 4-6 consists of comb mold electrodes 4a, 4b, 5a, 5b, 6a, and 6b of a pair, respectively. Reflectors 7 and 8 are arranged at the surface wave propagation direction both sides of the field in which IDT 4-6 is formed. Moreover, it is IDT 4 and 6, while it goes away, and common connection of the mold electrodes 4a and 6a is made, and they are connected at the node 9. The serial arm resonator 2 is connected between this node 9 and an input terminal 10. The serial arm resonator 2 has the structure which has arranged reflectors 12 and 13 on both sides of IDT11.
[0006] Moreover, it is an output side IDT5, while it goes away and mold electrode 5a is connected at the node 14. The node 14 is connected to the output terminal 15. Moreover, the juxtaposition arm resonator 3 is connected between a node 14 and ground potential. The juxtaposition arm resonator 3 has the reflectors 17 and 18 arranged at the both sides of IDT16 and IDT16.
[0007] It goes away SAW resonator filter 1, and the mold electrodes 4b, 5b, and 6b are connected to ground potential, respectively. Moreover, this serial arm resonator 2 is connected so that the resonance frequency of the above-mentioned serial arm resonator 2 may be located in the passband of the SAW resonator filter 1, and parallel connection of this juxtaposition arm resonator 3 is carried out so that the antiresonant frequency of the juxtaposition arm resonator 3 may be located in the passband of the SAW resonator filter 1.
[0008] With the above-mentioned surface acoustic wave equipment, namely, the inside of three IDT(s) 4-6 of the 3 electrode type length joint duplex mode SAW resonator filter 1, By carrying out series connection of the serial arm resonator 2 to outside IDT 4 and 6 so that resonance frequency may be located in the passband of the SAW resonator filter 1 With the impedance-frequency characteristics of this serial arm resonator, reduction of VSWR by the side of IDT4 of the outside of the SAW resonator filter 1 and 6 is achieved, and the magnitude of attenuation especially in the decay area by the side of high frequency outside a passband is expanded. Moreover, expansion of the magnitude of attenuation especially in the decay area by the side of low frequency is achieved by the reduction list of VSWR by the side of IDT5 of the center of the SAW resonator filter 1 passband outside with the impedance-frequency characteristics of this juxtaposition arm resonator 3 by carrying out parallel connection of the above-mentioned juxtaposition arm resonator 3 to IDT5 of the center of the above-mentioned SAW resonator filter so that the antiresonant frequency may be located in the passband of the SAW resonator filter 1.

[Translation done.]

EFFECT OF THE INVENTION

[The means for solving a technical problem and an effect of the invention] Accomplish this invention in order to attain the above-mentioned technical problem, and according to the large aspect of affairs of this invention The surface wave substrate which has a piezo-electric substrate or a piezo-electric thin film, It does not have the many electrode type length joint duplex mode SAW resonator filter which has the reflector of the pair arranged at the surface wave propagation direction both sides of the field in which five or more IDT(s) currently formed so that said piezo-electric substrate top or said piezo-electric thin film may be touched, and said IDT are prepared, and a reflector. And it has the juxtaposition arm resonator which consists of a 1 terminal-pair SAW resonator by which parallel connection was carried out to said SAW resonator filter so that resonance frequency might be located in a low frequency side rather than the passband of said SAW resonator filter. The surface acoustic wave equipment with which an input side edge child is characterized by being the node of said SAW resonator filter and said juxtaposition arm resonator is offered.
[0015] Since parallel connection of the above-mentioned juxtaposition arm resonator is carried out to the many electrode type length joint duplex mode SAW resonator filter by the above-mentioned relation according to this invention, the power impressed from an input terminal will be distributed by a SAW resonator filter and the juxtaposition arm resonator, and power-proof nature is effectively raised by it.
[0016] Moreover, since the above-mentioned juxtaposition arm resonator is prepared so that the resonance frequency may be located in the field by the side of low frequency rather than the passband of a SAW resonator filter, the magnitude of attenuation in the decay area by the side of the low frequency of a passband is raised. In addition, the reflection coefficient in an inhibition zone is also raised so that clearly from explanation of the below-mentioned operation gestalt.
[0017] Moreover, on the specific aspect of affairs of this invention, the above-mentioned many electrode type length joint duplex mode SAW resonator filter has five or more IDT(s) [odd], and let IDT of this odd number individual by turns be an input side IDT or an output side IDT along the surface wave propagation direction. In this case, let two IDT (s) nearest to the reflector of the above-mentioned pair be input sides IDT. Moreover, a number containing two IDT(s) nearest to the reflector of this pair of the electrode finger of an input side IDT of total is made [more] than total of the number of the electrode fingers of an output side IDT, and the above-mentioned juxtaposition arm resonator is connected to the input side IDT.
[0018] With the surface acoustic wave equipment offered according to this specific aspect of affairs In the operation effectiveness of the surface acoustic wave equipment offered according to the large aspect of affairs of above-mentioned this invention, in addition, since the number of input sides IDT increases more than the number of output sides IDT, Namely, since the input side IDT and the output side IDT are arranged by turns along the surface wave propagation direction so that two IDT(s) nearest to the reflector of a pair may serve as an input side IDT, The electrode finger gross area of IDT of the side to which power is impressed becomes large, therefore the power-proof nature in an input side edge child's inhibition zone can be raised further.
[0019] moreover -- the still more specific aspect of affairs of this invention -- as a piezo-electric substrate -- 36 degreeY cut X propagation LiTaO3 a substrate uses -- having -- the ratio of the width of face w of the electrode finger of IDT, and the wavelength lambda of a surface wave -- w/lambda is set to w/lambda <=0.32. In this case, 36 degreeY cut X propagation LiTaO3 with a large and electromechanical coupling coefficient and the temperature characteristic good as a piezo-electric substrate Since the substrate is used, the temperature characteristic can offer easily the surface acoustic wave equipment which has sufficient bandwidth good. In addition, since the ratio of the width of face w of the

electrode finger of IDT and the wavelength lambda of a surface wave is made or less into 0.32 as mentioned above, In the configuration which constituted five or more IDT(s) [odd] so that clearly from explanation of the below-mentioned operation gestalt A large number can come out relatively, the electrode finger gross area of a certain input side IDT can be relatively enlarged further compared with the electrode finger gross area of an output side IDT, and it can raise power-proof nature further.

[0020] In this invention, at least one serial arm resonator which consists of 1 terminal-pair SAW resonators so that antiresonant frequency may consist of a passband of a SAW resonator filter a high-frequency side is connected to an output side IDT in the configuration which has five or more IDT(s) [odd] preferably offered according to the specific aspect of affairs of above-mentioned this invention. With the configuration which connected at least one serial arm resonator further, the magnitude of attenuation in the decay area by the side of high frequency may be effectively increased rather than a passband, without spoiling not only the reflection coefficient in power-proof nature and an inhibition zone but a phase.

[0021] Moreover, the surface wave substrate which has a piezo-electric substrate or a piezo-electric thin film on another aspect of affairs of this invention, The reflector arranged at the surface wave propagation direction both sides of the field in which five or more INTADEJITARUTORANSUDEYUSA [odd] and this INTADEJITARUTORANSUDEYUSA which are formed so that said piezo-electric substrate top or said piezo-electric thin film may be touched are prepared It does not have the many electrode type length joint duplex mode SAW resonator filter which it has, and a reflector. And the 1st juxtaposition arm resonator which consists of a 1 terminal-pair SAW resonator by which parallel connection was carried out to the SAW resonator filter so that resonance frequency might be located in the frequency domain by the side of low frequency rather than the passband of said SAW resonator filter, It has at least one serial arm resonator which consists of 1 terminal-pair SAW resonators connected so that it might connect with said output side INTADEJITARUTORANSUDEYUSA and the antiresonant frequency might consist of a passband of said SAW resonator filter a high-frequency side. In said SAW resonator filter, a number containing two INTADEJITARUTORANSUDEYUSA nearest to the reflector of a pair of the electrode finger of input-side INTADEJITARUTORANSUDEYUSA of total It is made [more] than total of the number of the electrode fingers of output side INTADEJITARUTORANSUDEYUSA. And said 1st juxtaposition arm resonator is connected to said input-side INTADEJITARUTORANSUDEYUSA. And it sets to the manufacture approach of surface acoustic wave equipment that the 2nd juxtaposition arm resonator is connected so that the resonance frequency may become said output side INTADEJITARUTORANSUDEYUSA from the antiresonant frequency of said serial arm resonator a high-frequency side. After connecting said 2nd juxtaposition arm resonator, the manufacture approach of the surface acoustic wave equipment characterized by connecting said at least one serial arm resonator is offered. According to this manufacture approach, in addition to the operation effectiveness of the surface acoustic wave equipment of this invention mentioned above, the magnitude of attenuation is further expandable to a high-frequency side over a larger frequency range from a passband.

[0022]

[Embodiment of the Invention] This invention is clarified by explaining the operation gestalt [un-limit] of this invention hereafter.

[0023] The 1st operation gestalt drawing 2 is the schematic-drawing-top view of the surface acoustic wave equipment concerning the 1st operation gestalt of this invention.

[0024] Surface acoustic wave equipment 21 is constituted using the piezo-electric substrate 22. The piezo-electric substrate 22 is the 36 degreeY cut X propagation $LiTaO_3$. It consists of a substrate. The many electrode type length joint duplex mode SAW resonator filter 23 and the juxtaposition arm resonator 24 are constituted by forming the below-mentioned various electrodes on the piezo-electric substrate 22.

[0025] That is, five IDT(s) 25-29 are arranged along the surface wave propagation direction in the SAW resonator filter 23 on the piezo-electric substrate 22. IDT 25, 27, and 29 is an input side IDT among IDT(s) 25-29, and IDT 26 and 28 is an output side IDT. Each IDT 25-29 has the comb mold electrodes 25a, 25b-29a of a pair, and 29b, respectively. Reflectors 30 and 31 are formed in the surface wave propagation direction outside of the field in which IDT 25-29 is formed. Reflectors 30 and 31 are constituted by the grating reflector which has two or more electrode fingers.

[0026] Moreover, the juxtaposition arm resonator 24 is constituted by the 1 terminal-pair SAW resonator, and has the configuration which comes to connect five IDT(s) 32a-32d with a serial. Each IDT(s) 32a-32d are constituted by the comb mold electrode of the pair which has two or more electrode fingers put mutually in between, respectively.

Moreover, all the logarithms of IDT(s) [32a-32d] opening length and an electrode finger are made the same.
[0027] the resonance frequency is a low frequency side, and the juxtaposition arm resonator 24 consists of a passband of the SAW resonator filter 23 a high-frequency side rather than an inhibition zone especially -- as -- an input side IDT25 -- it goes away 29 and connects with the mold electrodes 25a and 29a electrically. That is, while the 1st comb mold electrode 25a, 27a, and 29a of the input side 25, 27, and IDT 29 of the SAW resonator filter 23 is connected at the node 34 connected to the input terminal 33, the juxtaposition arm resonator 24 is connected at this node 34. The terminal of the opposite side of the juxtaposition arm resonator 24 is connected to ground potential. Moreover, the 2nd comb mold electrode 25b, 27b, and 29b of the input side 25, 27, and IDT 29 of the SAW resonator filter 23 is also connected to ground potential.
[0028] Moreover, common connection of the 1st comb mold electrode 26a and 28a of an output side 26 and IDT 28 is made, and it is connected to the output terminal 35. The 2nd comb mold electrode 26b and 28b of IDT 26 and 28 is connected to ground potential, respectively.
[0029] The magnitude-of-attenuation frequency characteristics of the above-mentioned SAW resonator filter 23 are shown in drawing 4 . In addition, in drawing 4 , the property shown as a continuous line B is a property which expanded the insertion loss of an axis of ordinate to the scale on the right-hand side of an axis of ordinate, and showed the important section of the property shown as a continuous line A.
[0030] Moreover, the impedance Smith chart of the above-mentioned SAW resonator filter 23 is shown in drawing 5 (a) and (b). In addition, drawing 5 (a) is the property as which drawing 5 (b) regarded the property seen from the terminal by the side of IDT 25 and 27 and 29 from the terminal by the side of IDT26 and 28. In addition, the passband of the above-mentioned SAW resonator filter 23 is 935-960MHz, and the inhibition zone by the side of low frequency is 890-915MHz.
[0031] Although the juxtaposition arm resonator 24 is connected to the above-mentioned SAW resonator filter 23 as mentioned above with the surface acoustic wave equipment 21 of this operation gestalt as mentioned above, the magnitude-of-attenuation frequency characteristics of passband inside and outside as the whole are shown in drawing 6 . In addition, in drawing 6 , a continuous line D is the property which expanded the insertion loss of an axis of ordinate on the scale on the right-hand side of an axis of ordinate, and showed the important section of the property shown as the continuous line C.
[0032] In the property shown in drawing 6 so that clearly, if drawing 4 was compared with drawing 6 , it turns out that the magnitude of attenuation is large near the passband in the field by the side of low frequency rather than the passband. That is, according to this operation gestalt, by connecting the above-mentioned juxtaposition arm resonator 24 to the SAW resonator filter 23 as mentioned above shows that the magnitude of attenuation is especially raised for the magnitude of attenuation in the low frequency side field outside a passband effectively in the high-frequency side field in the above-mentioned inhibition zone.
[0033] Moreover, drawing 7 (a) and (b) show the impedance Smith chart of the surface acoustic wave equipment 21 of this operation gestalt, and (a) shows the property as which (b) regarded the property seen from the input terminal from the output terminal. If the property shown in drawing 5 (a) is compared with the property shown in drawing 7 (a), it turns out that the reflection coefficient [in / in the direction of the property shown in drawing 7 (a) / an inhibition zone, i.e., the passband of the other party,] is large.
[0034] In addition, with the surface acoustic wave equipment 21 of this operation gestalt, not only IDT 25, 27, and 29 but IDT(s) 32a-32d which constitute the juxtaposition arm resonator 24 are connected to the input terminal 33. Therefore, it turns out that the electrode finger gross area of IDT connected to the input side edge child becomes large to the electrode finger gross area of IDT 5 and 16 in the conventional surface acoustic wave equipment shown in drawing 1 .
[0035] That is, with this operation gestalt, since the above-mentioned juxtaposition arm resonator 24 is connected to the SAW resonator filter 23 by the above-mentioned relation, in the decay area outside a passband, especially the decay area by the side of low frequency, the magnitude of attenuation is expandable. In addition, since the reflection coefficient in an inhibition zone may be made high when it uses as a receiving-side filter, for example in the antenna top of a cellular phone, the loss in the passband of a transmitting side can be controlled effectively.
[0036] Moreover, since the above-mentioned juxtaposition arm resonator 24 was connected, as it mentioned above, since the power impressed from the input terminal is distributed by the SAW resonator filter 23 and the juxtaposition arm resonator 24, power-proof nature is raised.

[0037] By the way, mechanical stress occurs in the electrode of IDT and the destruction at the time of supplying large power to surface acoustic wave equipment is considered that the atom in the electrode which constitutes IDT is because migration starts, when exciting a surface wave.
[0038] Drawing 3 is drawing showing the width of face w of the above-mentioned electrode finger in IDT, the wavelength lambda of a surface wave, and relation with the decussation width of face t. With reference to drawing 3 , the further conditions which can raise power-proof nature are explained.
[0039] For example, with the conventional 3 electrode type length joint duplex mode SAW resonator filter shown in drawing 1 , in order to attain broadband-ization, when the number of the electrode finger of IDT is reduced, in order to set the impedance of I/O to 50 ohms, decussation width of face t of IDT needed to be enlarged, or width of face w of the electrode finger of IDT needed to be enlarged. Therefore, in order to reduce the resistance loss in IDT conventionally, the above-mentioned decussation width of face t was made small, and width of face w of an electrode finger was made thick to 0.35 or more times of wavelength lambda.
[0040] on the other hand -- since five IDT(s) of IDT 25-29 are prepared with the surface acoustic wave equipment 21 of this operation gestalt, even if it is the case where it considers as the same decussation width of face as the case where it is a 3 electrode mold SAW resonator filter -- every -- width of face of the electrode finger in IDT 25-29 can be made thinner than the width of face of the electrode finger in IDT of a 3 electrode mold SAW resonator filter, and an I/O impedance can be considered as 50-ohm pure resistance.
[0041] The invention-in-this-application person changed the number of IDT(s), and investigated the relation of the width of face w of an electrode finger and the decussation width of face t from which an I/O impedance serves as 50-ohm pure resistance. Consequently, the result shown in drawing 8 was obtained. In addition, in the relation shown in drawing 8 , on the basis of the case where the fractional band width in t/lambda =0.25 is as fixed as 4%, fractional band width is asked for the above-mentioned relation as it is fixed.
[0042] In addition, continuous-line E-H of drawing 8 is [-- The relation in the case of 9 electrode molds is shown.] a continuous line E, respectively. -- They are 3 electrode molds and a continuous line F. -- They are 5 electrode molds and a continuous line G. -- They are 7 electrode molds and a continuous line H. clear from drawing 8 -- as -- the decussation width of face t -- case it is the same -- (i.e., a ratio) case t/lambda is equal -- 3 electrode molds -- setting -- a ratio -- a more considerable configuration than w/lambda =0.35 -- 5 electrode molds -- a ratio -- it turns out that it can realize less than [w/lambda =0.15]. That is, in order to attain broadband-ization, when the number of the electrode finger in IDT is reduced, in order to make the impedance during I/O into a predetermined value, with this operation gestalt, it turns out that there is no need of making width of face of an electrode finger thick.
[0043] On the other hand, it turns out that the lifetime which results in a short circuit by inter-electrode migration becomes so long that spacing of the signal line and earth wire in IDT is large. Therefore, with this operation gestalt, when the wavelength lambda of IDT becomes short by RF-ization, since width of face w of an electrode finger can be narrowed as mentioned above, it turns out that power-proof nature can be raised effectively.
[0044] As mentioned above, with this operation gestalt, it not only can raise power-proof nature by the ability making thin width of face w of an electrode finger as mentioned above, but Since the input side IDT is made [many] compared with three IDT(s) 25, 27, and 29 and IDT 26 and 28 of an output side and IDT(s) 32a-32d of the above-mentioned juxtaposition arm resonator 24 are formed further, Since the gross area of the electrode of near IDT with which power is impressed can be made larger than the gross area of the electrode of an output side IDT, it can also raise effectively the power-proof nature in an input side edge child's inhibition zone.
[0045] Although the surface acoustic wave equipment 21 of the operation gestalt of the modification 1st of the 1st operation gestalt was constituted as mentioned above, preferably, the ratio of the width of face w of an electrode finger and the wavelength lambda of a surface wave in IDT 25-29 of the SAW resonator filter 23 of the above-mentioned surface acoustic wave equipment is set to w/lambda <=0.32, and power-proof nature is further raised by it. That is, if electrode finger decussation width of face of IDT in a SAW resonator filter is made small, since an electrode surface product becomes small, power-proof nature will deteriorate. Then, it investigated how total of the electrode finger area of IDT which influences power-proof nature would change with the number of the width of face w and IDT of the electrode finger in the electrode configuration which has various numbers of IDT(s). the case where IDT(s) of drawing 9 - drawing 11 are five pieces, seven pieces, and nine pieces, respectively -- the ratio of the decussation width of face t of an electrode finger, and wavelength lambda -- the value which spent the number n of the electrode finger of an input side 25, 27, and IDT 29 on t/lambda, and a ratio -- it is drawing showing relation with w/lambda. The product of the

number n of the decussation width of face t and an electrode finger shows the amount equivalent to the electrode surface product of IDT here, and the total numbers of the electrode finger of the input side IDT in case IDT(s) are five pieces, seven pieces, and nine pieces are n5 =91, n7 =136, and n9 =195, respectively.

[0046] Moreover, with the surface acoustic wave equipment using three conventional IDT(s), as mentioned above, width of face w of an electrode finger was made into 0.35 or more times of wavelength lambda. Then, in drawing 9 - drawing 11 , for the comparison, - mark was attached and the value of txn/lambda in the conventional 3 electrode mold surface acoustic wave equipment in w/lambda =0.35 was shown collectively.

[0047] With the configuration using five or more IDT(s), txn/lambda whose width of face w of an electrode is an amount equivalent to area as the number of IDT(s) increases in a fixed case is large, and the amount of the case where five IDT(s) are used is the smallest so that clearly from drawing 9 - drawing 11 .

[0048] therefore, the case where five or more IDT(s) are used as shown in drawing 9 - drawing 11 -- a ratio -- it turns out that 0.32 or less [then] and the electrode gross area of an input side IDT can be enlarged for w/lambda, and power-proof nature can be raised further.

[0049] The 2nd operation gestalt drawing 12 is a schematic-drawing-top view for explaining the surface acoustic wave equipment concerning the 2nd operation gestalt of this invention. For surface acoustic wave equipment 41, it is constituted using the piezo-electric substrate 42, and the piezo-electric substrate 42 is the 36 degreeY cut X propagation LiTaO3. It consists of a substrate. The many electrode type length joint SAW resonator filter 43, the juxtaposition arm resonator 44, and the serial arm resonator 60 are constituted by forming the below-mentioned various electrodes on the piezo-electric substrate 42.

[0050] The SAW resonator filter 43 and the juxtaposition arm resonator 44 are constituted like the SAW resonator filter 23 and the juxtaposition arm resonator 24 concerning the 1st operation gestalt. Therefore, about the same part, the detailed explanation is omitted by ****** which attaches the same reference number.

[0051] The place where this operation gestalt differs from the 1st operation gestalt is to connect the serial arm resonator 60 to the output side of the SAW resonator filter 43. That is, the serial arm resonator 60 has the reflectors 62 and 63 which consist of a grating reflector arranged on the surface-wave propagation direction outside of IDT61 and IDT61 arranged in the center. IDT61 has the comb mold electrodes 61a and 61b of the pair which has two or more electrode fingers put mutually in between. It is the output side 26 and IDT 28 of the SAW resonator filter 43, while it goes away, and common connection of the mold electrodes 26a and 28a is made, they go away serial arm resonator 60, and are connected to mold electrode 61a.

[0052] Therefore, with the surface acoustic wave equipment 41 concerning the 2nd operation gestalt, the input side 25, 27, and IDT 29 of the SAW resonator filter 43 is connected with the juxtaposition arm resonator 44 at the node 34 connected to the input terminal 33. On the other hand, the output side 26 and IDT 28 is connected to the output terminal 35 through the serial arm resonator 60. In addition, the passband of the SAW resonator filter 43 is 935-960MHz like the case of the 1st operation gestalt, and an inhibition zone is 890-915MHz.

[0053] The juxtaposition arm resonator 44 is connected to IDT 25, 27, and 29 so that the resonance frequency may serve as a field by the side of low frequency from the above-mentioned inhibition zone rather than the field and passband by the side of high frequency. Moreover, the serial arm resonator 60 is connected to IDT 26 and 28 so that the antiresonant frequency may be located in the decay area by the side of high frequency rather than the passband of the SAW resonator filter 43.

[0054] The magnitude-of-attenuation frequency characteristics of passband inside and outside as the whole surface acoustic wave equipment 41 of this operation gestalt are shown in drawing 13 . In addition, the continuous line J of drawing 13 is a property which the insertion loss of an axis of ordinate is expanded on the scale on the right-hand side of an axis of ordinate, and shows the important section of the property shown as the continuous line I.

[0055] If the magnitude-of-attenuation frequency characteristics shown in drawing 13 are compared with drawing 6 which is the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment of the 1st operation gestalt, with the surface acoustic wave equipment 41 of this operation gestalt, it turns out that the magnitude of attenuation is large also in the decay area by the side of high frequency rather than the passband so that clearly. That is, it turns out the magnitude of attenuation in the frequency domain by the side of the high frequency of the area within the above-mentioned inhibition is not only expanded, but that the magnitude of attenuation becomes large in the decay area by the side of high frequency rather than a passband.

[0056] That is, with surface acoustic wave equipment 41, first, since the juxtaposition arm resonator 44 is connected to

the input side 25, 27, and IDT 29 so that the resonance frequency may serve as a frequency domain by the side of the high frequency of an inhibition zone, the magnitude of attenuation in the frequency domain by the side of the low frequency outside a passband, especially the frequency domain by the side of the high frequency of the area within inhibition is expanded to the SAW resonator filter 43.

[0057] Moreover, the power impressed to an input terminal 16 will be distributed by the input side 25, 27, and IDT 29 and the juxtaposition arm resonator 44 of the SAW resonator filter 43, and power-proof nature is raised by connection of the above-mentioned juxtaposition arm resonator 44. In addition, since five IDT(s) 25-29 are formed and the input side IDT is constituted from the SAW resonator filter 43 by three IDT(s) 25, 27, and 29, By connecting the juxtaposition arm resonator 44 which are many pairs and comes to carry out series connection of two or more steps of IDT(s) to a list, since power is impressed to the input side IDT with many numbers of an electrode finger The gross area of the electrode of IDT with which power is impressed is expanded, and the power-proof nature in an input side edge child's inhibition zone is raised by it.

[0058] In addition, expansion of the magnitude of attenuation in the decay area by the side of high frequency is also achieved rather than a passband, without spoiling an input side edge child's power-proof nature and reflection coefficient in an inhibition zone which were mentioned above, since the above-mentioned serial arm resonator is connected so that the antiresonant frequency may be located in the decay area by the side of high frequency rather than the passband of the SAW resonator filter 43.

[0059] In addition, with this operation gestalt, although one serial arm resonator 60 was used, when you may connect between the output terminal 35 and the SAW resonator filter 43 and two or more serial arm resonators connect more serial arm resonators, the magnitude of attenuation in the frequency domain by the side of high frequency can be further expanded rather than a passband.

[0060] Moreover, in using surface acoustic wave equipment 41 as an antenna common machine of a cellular phone with which a part of decay area by the side of low frequency turns into an inhibition zone (namely, passband of the other party) from a passband, in order to raise the impedance of an inhibition zone, it is necessary to rotate the phase of the impedance in an input terminal. Since a phase will turn conversely to the hand of cut of a phase when a serial arm resonator is connected to an input terminal, the long phase machine of track length is needed. However, if the track length of a phase machine is lengthened, the loss in a phase machine will become large, and the size of a phase machine will also become large. On the other hand, with this operation gestalt, expansion of the magnitude of attenuation in the decay area by the side of high frequency can be aimed at rather than a passband as mentioned above, without having effect of the phase on the impedance in an input terminal 33, since the serial arm resonator 60 is connected to the output side.

[0061] The 3rd operation gestalt drawing 15 is a schematic-drawing-top view for explaining the surface acoustic wave equipment concerning the 3rd operation gestalt of this invention. For surface acoustic wave equipment 81, it is constituted using the piezo-electric substrate 82, and the piezo-electric substrate 82 is the 36 degreeY cut X propagation $LiTaO_3$. It consists of a substrate.

[0062] The 5 electrode type length joint duplex mode SAW resonator filter 83, the juxtaposition arm resonator 84, the serial arm resonator 85, and the 2nd juxtaposition arm resonator 86 are constituted by forming the various below-mentioned electrodes on the piezo-electric substrate 82. But the SAW resonator filter 83 and the juxtaposition arm resonator 84 are constituted like the SAW resonator filter 23 of the surface acoustic wave equipment 21 of the 1st operation gestalt, and the juxtaposition arm resonator 24. Moreover, the serial arm resonator 85 is constituted like the serial arm resonator 60 used with the surface acoustic wave equipment of the 2nd operation gestalt. Therefore, about the same part, detailed explanation is omitted by ****** which attaches the same reference number.

[0063] The point that the surface acoustic wave equipment 81 of this operation gestalt differs from the surface acoustic wave equipment 42 concerning the 2nd operation gestalt has the 2nd juxtaposition arm resonator 86 in connecting at the node 87 further. That is, common connection of the output side 26 and IDT 28 of the SAW resonator 83 is made, it connects at the node 88, and the 2nd juxtaposition arm resonator 86 is connected between the node 87 between this node 88 and the serial arm resonator 85, and ground potential.

[0064] The 2nd juxtaposition arm resonator 86 has the reflectors 90 and 91 formed in the surface wave propagation direction both sides of IDT89 and IDT89 which consist of comb mold electrodes 89a and 89b of a pair.

[0065] Therefore, with surface acoustic wave equipment 81, the juxtaposition arm resonator 84 is connected between the nodes 34 and ground potentials which are connected to an input terminal 33, and the SAW resonator filter 83 and

the serial arm resonator 85 are connected between the node 34 and the output terminal 35, and it has the configuration to which the 2nd juxtaposition arm resonator 86 was further connected between the output side of a node 87 83, i.e., a SAW resonator filter, and ground potential.

[0066] In the above-mentioned configuration, like the case of the 1st operation gestalt, parallel connection of the resonance frequency of the juxtaposition arm resonator 84 is carried out to the SAW resonator filter 83 so that it may be located in a low frequency side rather than the passband of the SAW resonator filter 83, and resonance frequency may be especially located in the high-frequency side of an inhibition zone also in the decay area by the side of low frequency.

[0067] Moreover, like the case of the surface acoustic wave equipment 41 of the 2nd operation gestalt, the serial arm resonator 85 is connected so that the antiresonant frequency may be located in the decay area by the side of high frequency rather than the passband of the SAW resonator filter 83.

[0068] On the other hand, after constituting the 2nd juxtaposition arm resonator 86 so that the resonance frequency may consist of antiresonant frequency of the serial arm resonator 85 a high-frequency side, and connecting the 2nd juxtaposition arm resonator 86, the serial arm resonator 85 is connected.

[0069] In addition, like the SAW resonator filters 23 and 43 which used the above-mentioned SAW resonator filter 83 with the 1st and 2nd operation gestalt, a passband is 935-960MHz and an inhibition zone is 890-915MHz.

[0070] The magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment 81 concerning the 3rd operation gestalt are shown in drawing 16 . The continuous line L in drawing 16 is a property which the insertion loss of an axis of ordinate is expanded on the scale on the right-hand side of an axis of ordinate, and shows the important section of the property shown as the continuous line K. Moreover, drawing 17 (a) and (b) show the impedance Smith chart of the terminal of the side containing IDT 25 and 29 of two outsides, and the terminal of the opposite side, respectively.

[0071] If drawing 16 is compared with drawing 13 which is the magnitude-of-attenuation frequency characteristics of the 2nd operation gestalt, with the surface acoustic wave equipment 81 of this operation gestalt, the damping property in the frequency domain by the side of high frequency will be further improved rather than a passband so that clearly. That is, it turns out that the big magnitude of attenuation is secured from a passband over a larger frequency range in the frequency domain by the side of high frequency. This is explained to a detail with reference to drawing 18 - drawing 21 .

[0072] When drawing 18 constitutes the surface acoustic wave equipment 81 shown in drawing 15 , the frequency characteristics at the time of connecting the serial arm resonator 85 first and connecting the 2nd juxtaposition arm resonator 86 after an appropriate time are shown, and drawing 19 (a) and (b) show the impedance Smith chart in that case. In addition, in drawing 18 , a continuous line N is a property which the insertion loss of an axis of ordinate is expanded on the scale on the right-hand side of an axis of ordinate, and shows the important section of the property shown as the continuous line M. Moreover, drawing 19 (a) and (b) show the impedance Smith chart of the terminal of the side containing IDT 25 and 29 of two outsides, and the terminal of the opposite side, respectively. If drawing 18 is compared with drawing 16 , it turns out that the magnitude of attenuation in the decay area by the side of high frequency is small rather than the passband so that clearly.

[0073] Moreover, drawing 20 shows the magnitude-of-attenuation frequency characteristics as the overall characteristic of the serial arm resonator 85 and the 2nd juxtaposition arm resonator 86 which were shown in drawing 15 . In drawing 20 , a continuous line P shows the property which expanded and showed the property shown as the continuous line O about the insertion loss of an axis of ordinate on the scale shown in the right-hand side of an axis of ordinate. Moreover, drawing 21 (a) and (b) show the impedance Smith chart by the side of a serial arm resonator, and the impedance Smith chart by the side of a juxtaposition arm resonator, respectively. The passband of drawing 7 (b) shows that the magnitude of attenuation differs in near 980MHz with drawing 21 (a) to the impedance in a high-frequency side, for example, near 980MHz, and impedance matching of (b).

[0074] Moreover, since the impedance of drawing 21 (b) serves as mismatching from the passband of drawing 7 (b) more by 50-ohm system to the impedance in the frequency domain by the side of high frequency, it turns out that the magnitude of attenuation becomes large.

[0075] Therefore, in connecting the above-mentioned serial arm resonator 85 and the 2nd juxtaposition arm resonator 86 to the SAW resonator filter 83, it turns out by connecting in order of the 2nd juxtaposition arm resonator 86 and the serial arm resonator 85 that the magnitude of attenuation can be effectively expanded over a larger frequency range in

the frequency domain by the side of high frequency rather than a passband.
[0076] In addition, with the surface acoustic wave equipment 81 of the 3rd operation gestalt, except having connected the juxtaposition arm resonator 86 of the above 2nd, and connecting the 2nd juxtaposition arm resonator 86 to a list in front of the serial arm resonator 85, since it is the same as that of the surface acoustic wave equipment of the 2nd operation gestalt, similarly the operation effectiveness in the surface acoustic wave equipment 41 of the 2nd operation gestalt can also be acquired.
[0077] That is, the magnitude of attenuation in the frequency domain by the side of low frequency, especially the frequency domain by the side of the high frequency of an inhibition zone is secured to sufficient magnitude from a passband like the case of the surface acoustic wave equipment of the 2nd operation gestalt, and it has sufficient power-proof nature, and the phase of the power-proof nature in an input side edge child's inhibition zone, a reflection coefficient, and an impedance is not spoiled.
[0078] in addition, the 1- mentioned above -- the 3rd operation gestalt -- as a piezo-electric substrate -- the above-mentioned 36 degreeY cut X propagation LiTaO3 although the substrate was used -- other piezo-electric substrates 3, for example, LiNbO, The substrate which may use the piezo-electric substrate which consists of Xtal etc., or consists of electrostrictive ceramics like the titanic-acid lead zirconate system ceramics may be used. Furthermore, the surface wave substrate which comes to form a piezo-electric thin film on an insulating substrate or a piezo-electric substrate may be used. as the above-mentioned piezo-electric thin film -- ZnO and Ta 2O5 etc. -- from -- what becoming can be mentioned.
[0079] Moreover, what is necessary is just to form IDT and a reflector using aluminum and aluminum alloy which are commonly used in surface wave equipment, although it can form with a proper conductive ingredient.

[Translation done.]

* NOTICES *

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] With the surface acoustic wave equipment mentioned above, expansion of the magnitude of attenuation in the decay area outside a passband is achieved by the reduction list of loss by connecting the serial arm resonator 2 and the juxtaposition arm resonator 3 to the 3 electrode type length joint duplex mode SAW resonator filter 1 as mentioned above.
[0010] On the other hand, at the antenna top of a cellular phone etc., the big power from a transmitting side is impressed to the inhibition zone (passband of a transmitting side) of the receiving-side (Rx side) filter. When large power was not able to be borne from a transmitting side when the above-mentioned surface acoustic wave equipment is used, for example, the power which is 2W was impressed as such a receiving-side filter, there was a problem of destroying in an instant.
[0011] Moreover, in using the above-mentioned surface acoustic wave equipment as a receiving-side filter of the antenna top for cellular phones, it has connected with the transmitting-side filter which sets up so that the impedance of an inhibition zone may be opened using a stripline etc., for example, consists of a filter using a dielectric resonator, or an SAW filter. However, although it was desired for the reflection coefficient of the receiving-side filter in the passband of a transmitting side to be large in order to have controlled loss of a transmitting side in this case, with the above-mentioned surface acoustic wave equipment, the reflection coefficient in the passband of a transmitting side could not fully be raised.
[0012] In addition, the magnitude of attenuation in the decay area by the side of high frequency is not more enough than a passband as a general description of a SAW resonator filter, therefore expansion of the magnitude of attenuation in the decay area by the side of high frequency is called for strongly.
[0013] This invention cancels the fault of the conventional surface acoustic wave equipment mentioned above, is low loss, and it not only can expand the magnitude of attenuation in the decay area by the side of low frequency rather than a passband, but is excellent in power-proof nature, and it aims at offering the surface acoustic wave equipment to which the magnitude of attenuation of the decay area by the side of high frequency is further expanded rather than the passband.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The top view for explaining the electrode structure of an example of conventional surface acoustic wave equipment.
[Drawing 2] The schematic-drawing-top view of the surface acoustic wave equipment concerning the 1st operation gestalt of this invention.
[Drawing 3] The expansion top view of IDT for explaining the electrode finger decussation width of face t, the width of face w of an electrode finger, and the wavelength lambda of a surface wave.
[Drawing 4] Drawing showing the magnitude-of-attenuation frequency characteristics of only the SAW resonator filter used with the 1st operation gestalt.
[Drawing 5] (a) And for the impedance Smith chart of a near terminal and the above-mentioned terminal including the input side IDT of two outsides, (b) is drawing showing the impedance Smith chart of the terminal of the opposite side, respectively.
[Drawing 6] Drawing showing the magnitude-of-attenuation frequency characteristics as the overall characteristic of the surface acoustic wave equipment concerning the 1st operation gestalt.
[Drawing 7] (a) And for the impedance Smith chart of a near terminal and the above-mentioned terminal including the input side IDT of two outsides, (b) is drawing showing the impedance Smith chart of the terminal of the opposite side as the overall characteristic of the surface acoustic wave equipment of the 1st operation gestalt, respectively.
[Drawing 8] a ratio in case the I/O impedance of the surface acoustic wave equipment shown in drawing 2 serves as 50-ohm pure resistance -- t/lambda and a ratio -- drawing showing relation with w/lambda.
[Drawing 9] a ratio in case the I/O impedance of the surface acoustic wave equipment of the 1st operation gestalt serves as 50-ohm pure resistance -- w/lambda and a ratio -- drawing showing relation with the value which multiplied t/lambda by the number n of the electrode finger of IDT.
[Drawing 10] a ratio in case the I/O impedance of the surface acoustic wave equipment of the 1st operation gestalt serves as 50-ohm pure resistance -- w/lambda and a ratio -- drawing showing relation with the value which multiplied t/lambda by the number n of the electrode finger of IDT.
[Drawing 11] a ratio in case the I/O impedance of the surface acoustic wave equipment of the 1st operation gestalt serves as 50-ohm pure resistance -- w/lambda and a ratio -- drawing showing relation with the value which multiplied t/lambda by the number n of the electrode finger of IDT.
[Drawing 12] The schematic-drawing-top view of the surface acoustic wave equipment concerning the 2nd operation gestalt of this invention.
[Drawing 13] Drawing showing the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment of the 2nd operation gestalt.
[Drawing 14] (a) And (b) is drawing showing the impedance Smith chart of the input side edge child containing IDT of two outsides of the surface acoustic wave equipment of the 2nd operation gestalt, and the impedance Smith chart of the terminal of the opposite side, respectively.
[Drawing 15] The schematic-drawing-top view of the surface acoustic wave equipment concerning the 3rd operation gestalt of this invention.
[Drawing 16] Drawing showing the magnitude-of-attenuation frequency characteristics of the surface acoustic wave equipment concerning the 3rd operation gestalt.

[Drawing 17] (a) And for (b), (b) is drawing in which the above-mentioned terminal shows the impedance Smith chart of the terminal of the opposite side for the impedance Smith chart of the terminal of an input side with which (a) contains IDT of two outsides by showing the impedance Smith chart in the surface acoustic wave resonator of the 3rd operation gestalt.
[Drawing 18] Drawing showing the magnitude-of-attenuation frequency characteristics as the overall characteristic at the time of connecting a juxtaposition arm resonator in the surface acoustic wave equipment of the 3rd operation gestalt after connecting a serial arm resonator.
[Drawing 19] (a) And for (b), (b) is drawing in which the above-mentioned terminal shows the impedance Smith chart of the terminal of the opposite side for the impedance Smith chart of the near terminal with which (a) contains IDT of two outsides by showing the impedance Smith chart as the overall characteristic at the time of connecting a serial arm resonator after connecting a juxtaposition arm resonator in the surface acoustic wave equipment of the 3rd operation gestalt, respectively.
[Drawing 20] Drawing showing the magnitude-of-attenuation frequency characteristics as the overall characteristic of the juxtaposition arm resonator used with the 3rd operation gestalt, and a serial arm resonator.
[Drawing 21] (a) And (b) is drawing showing the impedance Smith chart as which (b) regarded the impedance Smith chart which looked at (a) from the serial arm resonator side edge child from the juxtaposition arm resonator side edge child by showing the impedance Smith chart in the overall characteristic of the 2nd juxtaposition arm resonator used with the 3rd operation gestalt, and a serial arm resonator, respectively.
[Description of Notations]
21 -- Surface acoustic wave equipment
22 -- Piezo-electric substrate
23 -- Many electrode type length joint duplex mode SAW resonator filter
24 -- Juxtaposition arm resonator
25, 27, 29 -- Input side IDT
26 28 -- Output side IDT
30 31 -- Reflector
32a-32d -- IDT
33 -- Input terminal
34 -- Node
35 -- Output terminal
41 -- Surface acoustic wave equipment
42 -- Piezo-electric substrate
43 -- Many electrode type length joint duplex mode SAW resonator filter
44 -- Juxtaposition arm resonator
60 -- Serial arm resonator
61 -- IDT
62 63 -- Reflector
81 -- Surface acoustic wave equipment
82 -- Piezo-electric substrate
83 -- Many electrode type length joint duplex mode SAW resonator filter
84 -- Juxtaposition arm resonator
85 -- Serial arm resonator
86 -- 2nd juxtaposition arm resonator

[Translation done.]